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CLUB-ROOT IN CRUCIFEROUS CROPS.

INVESTIGATION BY PLANT RESEARCH STATION.

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(1) A Preliminary Survey.

THE information in this section is compiled from notes made in the course of a survey of the relation of cruciferous crops to disease in the Wellington, Hawke's Bay, and Taranaki Provinces of New Zealand during the season 1927–28. The notes were based on the experience of a number of farmers visited, and a summary of the position in each district is given.

HUTT VALLEY MARKET-GARDEN AREA, WELLINGTON.

The chief cruciferous crops in this district are cabbages, cauliflowers, &c. Practically all the growers interviewed asserted that club-root (*Plasmodiophora brassicae* Wor.) was the most serious disease they had to combat. The summer crop is frequently very severely attacked, but the winter crop does not suffer to the same extent. One man has grown from three to five winter crops in succession on the same area without suffering severe club-root infection. The rotation practice appears to be summer cabbage, winter cabbage, rhubarb, or other non-susceptible crop for three years.

The general belief is that club-root causes most loss on the drier or higher areas of a paddock. Most agree that lime and stable manure are slightly beneficial in securing a reduction of the disease, while artificial fertilizers are stated to increase its incidence. Stable manure, however, is now so expensive that its use is impracticable. One grower claims that by heavy annual liming he has been able to use the same seed-bed for five years in succession without being troubled by the disease. Another states that by applying ½ ton of burnt lime per acre over his holding for many years past he can grow several successive crops of cabbage on the same land, and that he has not noticed club-root on his property.

Opinions vary as to the period of persistence, but most growers state that it is from three to five years. There appears to be a slight

majority in favour of the three-year period. The disease has been recorded in three places as appearing in the first crop from lea land of twelve to eighteen years' standing and also in new seed-beds, and on this evidence a number of farmers hold the belief that the disease is carried with the seed.

WAIRARAPA.

In the Wairarapa district many farmers were visited, but none considered club-root as a menace. The practice appears to be to sow swedes or turnips on land broken from lea, followed with rape, and then put back into grass for seven to ten years. Towards the southern part of the district swedes appear to be sown only as a crop between ploughing lea and resowing grass, and not for the value of the swedes. Here diamond-back moth (*Plutella maculipennis*) is cited as being the most serious trouble. Where two crops of brassicas are grown in succession the most club-root noticed is usually only small patches in the second crop, and the only case of severe infection mentioned was in a paddock which had been used as a run-off from rape in the previous year. The majority of farmers stated that club-root was most troublesome on the drier parts of a paddock; only one man had noticed it more severe in the lower areas. Only one farmer followed a definite cropping system—a four-year rotation in which only one crop of crucifers is sown, and which follows grass or clover. On the whole, crucifers appear to be grown in this district as an easy crop in the renewing of pasture, and though club-root may be present it is rarely noticed and causes little damage.

BUSH DISTRICTS (RONGO, EKETAHUNA, NEWMAN, PAHIATUA, WOODVILLE).

Throughout the bush districts swedes are sown mainly on so-called virgin country from which stumps have recently been cleared. In the southern part of the district it is common to take two cruciferous crops in succession from a paddock and then lay it down in grass. The first crop is usually very satisfactory, while the second is frequently badly clubbed. In some cases it has been the practice to feed out crucifers on ground in which it is intended to grow swedes during the following year, and in these cases swedes on stump land have been badly clubbed. Farther north towards Pahiatua there seems a tendency, due to the ravages of club-root, to take only one cruciferous crop before resowing grass. Top-dressing of pastures is stated to be supplying sufficient feed to replace swedes, with the result that the areas in that crop are decreasing rapidly. About Woodville farmers state that no roots are grown, as pasture top-dressing supplies the necessary feed.

SOUTHERN HAWKE'S BAY.

Farmers here state that club-root always appears in a second cruciferous crop from stump or lea land, and causes most loss on light hillsides, but that diamond-back moth causes the most serious trouble. The usual rotation practice is from stump land to swedes, turnips, or rape, then grass for an indefinite period. There is a belief among the farmers that top-dressing will do away with the necessity of swede-growing, which will dispense with the need for keeping a team and prove a more economic method of supplying feed.

NORTHERN HAWKE'S BAY.

In this district swede-growing is considered a very uncertain undertaking on account of ravages of diamond-back moth and loss through dry-rot (*Phoma lingam*). Club-root is cited as being severe only about Hatuma, where farmers attempt to grow rape crops in three successive years on the same ground, with the result that club-root severely attacks both the second and third crops.

On the higher land, above 1,500 ft., swede-growing is more certain, and two cruciferous crops are taken in succession. Club-root usually appears in the second crop, but is not troublesome, and one farmer claims that it is worse on dry hill-tops. About Tutira club-root is not troublesome, but has been recorded as appearing in a crop from virgin land and in second crops from lea land. Here diamond-back moth and dry-rot cause serious trouble. Most farmers consider that swedes will be more necessary than ever in view of the increased summer stocking due to pasture top-dressing. The general procedure where roots are grown appears to be lea, swedes, turnips or rape, then grass for several years.

WELLINGTON-WEST COAST DISTRICTS (OTAKI, LEVIN, SHANNON, LINTON, FOXTON, CARNARVON, SANDON, AND BULLS).

Near Otaki the practice appears to be to take one crop of crucifers—usually swedes from lea land—then to oats or mangels, and back to grass. Farmers state that they would take two cruciferous crops were it not for losses due to club-root. Throughout the district a large number of farmers are trying mangels, as they claim that club-root and other diseases make the growing of cruciferous crops very uncertain.

Some farmers have ceased growing crucifers on account of club-root, and rely solely on top-dressing to supply the necessary feed, while one man claims that ridging the swedes reduces the infection. Where the farm contains sandhills and drained swamp areas, it appears common to grow a crop free from club-root following lea on the sandhills, while a similar crop on the swamp areas would develop club-root. This appears due to the fact that crucifers are usually fed out on the flat swamp areas.

Five cases were recorded of areas which had been in grass for long periods up to twenty years, and which on being ploughed and sown to swedes developed club-root in the first crop, though no crucifers had been fed on the ground from a contaminated paddock. North of Levin there appear to be two types of crop systems—lea, swedes, and back to grass; or lea, swedes, turnips or rape, then back to grass. Club-root is stated to be troublesome only in the second crop. Diamond-back moth is only severe in very dry summers, and dry-rot is said to be more severe in second-year crops. Mangels appear to be replacing swedes in a number of places.

POHANGINA, APITI, RANGIWAHIA.

At Pohangina club-root appears to be of little trouble, as most farmers state they take only one cruciferous crop from a paddock (but where more crops are taken dry-rot was in evidence). At Apiti

the farmers state that several years ago they could grow crop after crop of crucifers without disease, but now can grow only one clean crop. One case was cited where land previously clubbed had lain for seven years in grass, after which, on sowing swedes, club-root developed. The farmer believed that the spores had persisted in the soil.

About Rangiwahia not more than two crops of crucifers can be taken from the same land, and the second crop is stated to be always clubbed. In one case club-root developed in swedes sown in land broken up from stumps. The following year this area (about 10 acres) was sown part in swedes and part in chou moellier. The swedes failed completely on account of club-root, but the chou moellier was only affected where it came into contact with an infected swede plant. Since then three other satisfactory successive crops of chou moellier have been taken from the same ground, and no apparent loss has accrued through attacks of club-root.

MARTON, HALCOMBE, STANWAY.

Club-root is stated to be often troublesome in the first crop from lea, and has been recorded on the first crop after breaking up stump land and on twenty-year-old pasture. In one case an area of bush was felled, stumped, and swedes sown, which became clubbed. Previously to the cropping there had been no stock on this area. One farmer estimated that club-root had reduced the areas of crucifers grown in his district to 10 per cent. of what it was fifteen years ago, and several offered the opinion that the disease was seed-borne. One man believed that the disease came in blood-and-bone manure from the freezing-works.

The general practice in this district appears to be lea, swedes, oats, peas, grass; or lea, swedes, rape, and grass sown together. It appears unusual to plough land for swedes unless it has been at least seven years in grass. In one case where the rotation was swedes, oats, peas, swedes, the second crop of swedes was badly clubbed, but this crop was probably sown about twenty-four months after the date of sowing the first crop of swedes. Swedes are considered essential to farm-management, or farmers say they would not endeavour to grow them.

The position regarding club-root between Marton and Wanganui appears similar, except that mangels and ensilage seem to be finding more favour as substitutes for swedes.

WANGANUI TO HAWERA.

Club-root is stated to be so severe in this area that swedes are a very uncertain crop, and are being replaced by mangels, lucerne, and hay. Top-dressing and ensilage may replace mangels, as the latter are considered too much trouble. Farmers state they can grow swedes only on so-called virgin land, and as most are coming to the end of this they believe it is unsafe to grow swedes. There appears to have been less trouble with club-root during the past two years.

SOUTH TARANAKI.

On account of disease, swedes are not considered a paying proposition unless in preparation for grass establishment. Only one

crop can be taken, and all remaining crops are severely clubbed. In place of swedes most farmers grow chou moellier, as it is not so severely affected by club-root as are swedes, or they replace crucifers with mangels, carrots, lucerne, or ensilage.

CENTRAL AND NORTH TARANAKI.

About Toko there appear to be large areas of swedes grown, but mainly as a preparation for establishing pastures. Swedes are only a success on lea land; chou moellier is replacing swedes where feed is required.

From Inglewood to the coast most farmers state that it is possible to get two cruciferous crops, but few do so on account of risk of club-root and dry-rot. Mangels, carrots, and ensilage are replacing crucifers, but farmers say they would prefer to grow swedes rather than mangels. Club-root does not appear to have been so bad for the past two years. On the coastal area north of New Plymouth very few crucifers are grown.

COASTAL AREA, NEW PLYMOUTH TO HAWERA.

Practically no swedes are grown in this area, on account of trouble with club-root. Turnips replace swedes, but club-root invariably appears in the second crop on the same area. Only a few mangels are grown, as the land is not suitable, and most farmers rely on hay alone. Between Opunake and Manaia mangels and lucerne have replaced swedes, which farmers say it is impossible to grow on account of club-root. During the past two years, however, club-root has caused less trouble, and farmers are considering returning to swede-growing, which they contend is necessary in view of the large areas being top-dressed.

General Comments on the Survey.

One of the most significant experiences of the survey was the statement made by farmers that were it not for club-root and dry-rot they would grow swedes and brassicas in place of mangels and the other substitutes that are grown to-day. In dairying districts top-dressing was said to be doing away with the necessity of swede-growing, but on sheep country the opinion was almost unanimous that more swedes would be required as top-dressing increased.

The most reliable information concerning the disease has been obtained from the Hutt Valley district, where practically all were agreed on the low amount of infection experienced in the winter crops, and opinions were very consistent (within two years) regarding the period of persistence in the soil. Though the general tendency in New Zealand has been to deprecate the use of lime as a remedy for club-root, two of the growers interviewed in the Hutt district are convinced of its value. Throughout the districts surveyed the disease is said to cause most loss in the drier parts of a field. This is possibly because the roots, deformed by club-root, do not supply sufficient moisture for the requirements of the plant, whereas in moister soil this is in part remedied by the production of adventitious roots, and though club-root may be present the farmer does not remark any loss on its account.

A striking feature of the survey is the lack of any attempt to practise ordinary sanitary precautions against the spread of club-root spores, even among the market gardens of the Hutt Valley. The severity and widespread nature of the disease, especially its appearance in the swede crops following lea of twelve to twenty years' standing, appear to indicate a considerable amount of ignorance concerning the means of dissemination of the spores and the precautions which should always be taken with land on which it is intended to sow crucifers. If it were generally known that the spores may be transferred from infected to healthy soil in surface-drainage water, with earth adhering to implements, the feet of horses and stock, boots of men or wheels of drays, &c., and, in the case of market and kitchen gardens, by the inclusion of diseased roots in the compost heap, there should be less trouble from the disease. When it is considered how freely an infected crop may be distributed about a farm in the operation of carting out feed to stock, and that the distribution does not cease with the infected crop alone, but may in subsequent years be continued through any of the spore-laden soil being carried to other areas by stock, implements, &c., or with soil adhering to a non-susceptible crop, such as mangels, it is not remarkable that club-root frequently appears on lea of long standing.

The results of experiments at the Plant Research Station show that infection is governed by spore load, though there is no simple relation between number of spores and degree of infection. A fairly large concentration of spores is necessary before any infection occurs. In view of this it appears that the chance of seed-borne spores causing general club-root throughout a paddock, though possible in odd cases, is practically remote, especially as no workers have yet succeeded in isolating spores of *P. brassicae* from the seed.

(2) Work at the Plant Research Station.

With the object of effecting a control of the disease, investigations were commenced at the Plant Research Station in 1928 to determine the life-history and responses to stimuli of the organism causing club-root of cruciferous crops. The work has been planned to investigate the presence of biological strains, factors governing means of dissemination, host range, varietal resistance of crucifers, and methods of control.

Preliminary Work.

Early work showed that the number of spores present had a considerable effect on the degree of infection. A test was made in which suspensions of different concentrations of spores were applied to rape plants growing in boxes of sterilized soil in a glasshouse. The suspensions contained from 4 grammes to 0·0002 grammes of fresh club-root-infected material per 100 cc. of water, and were estimated to contain from five and a third million spores per cubic centimetre to about 260 per cubic centimetre. The results are shown in Table 1.

From this table it appears that there is no correlation between the spore load and percentage of infected plants, but that the greater the number of spores present the more severe is the infection. Further work on similar lines has produced comparable results, but details will be reserved for future publication.

Table 1.—Incidence of Club-root Infection.

Strength of Suspension.	Estimated Number of Spores per Box.	Total Plants examined.	Number of Plants infected with Club-root.
Per Cent.			
0·0002	26,500	42	1
0·002	265,000	42	5
0·02	2,651,000	48	2
0·2	26,510,000	44	21
2·0	265,100,000	44	44
4·0	530,000,000	44	43

Biological Strains of the Organism.

Tests to locate biological strains of club-root pathogenic to only one host or to a series of hosts were commenced in a greenhouse, where inconclusive and conflicting results were obtained. Later, inoculation experiments were conducted on non-infected ground in which non-inoculated plots were left as controls. In no case did a control plot produce any club-root-infected plants, while high percentages were registered in the artificially inoculated plots.

The results of these trials showed that club-root spores from infected roots of chou moellier, swede, mustard, cabbage, rape, and soft turnips were equally pathogenic when each was inoculated on swede, soft turnip, yellow turnip, rape, cabbage, kales, and chou moellier. From this it appears that if there are any biological strains of the club-root organism they are not of economic importance in New Zealand. The determination of this point is of considerable importance to the work in hand, and indicates that the disease cannot be avoided by sowing of susceptible crops in any special order. This conclusion is supported by McLeod, at Frederickton, N.B., Canada, who, in the course of private correspondence, advises the writer that he has so far been unable to procure a satisfactory demonstration of biological strains.

Factors governing Infection.

The equipment necessary for an intensive study of the soil conditions most favourable to infection is not at present available here. The results of work overseas have shown that the development of the disease is favoured by wet(6)(8) acid soils(1)(2), and does not occur readily when the soil temperature is less than 18° C. (64° F.)(6)(8).

During the first season's work (1928) at Palmerston North no club-root developed in an unheated glasshouse during July, August, and early September, but developed later (in October) in the same soil. During the following winter the same technique was used, and the disease regularly appeared in plants grown in a glasshouse where the soil temperature was maintained at from 62° to 68° F. (The air temperature fluctuated between 86° F. and 52° F.)

An unexplained but interesting feature occurred during the artificial inoculation of an area with the club-root organism by transplanting rape seedlings the roots of which had been dipped in a suspension of spores in water. The first planting of about 4,000 plants

was followed by rain and commenced growth immediately, while the remainder of the planting, consisting of 45,000 plants planted out from two to seven days later, received no rain for ten days, and though the majority of plants eventually grew they received a serious initial set-back. Club-root failed to develop in the first sowing of 4,000 plants, while 80 to 90 per cent. of infection was recorded over the remainder

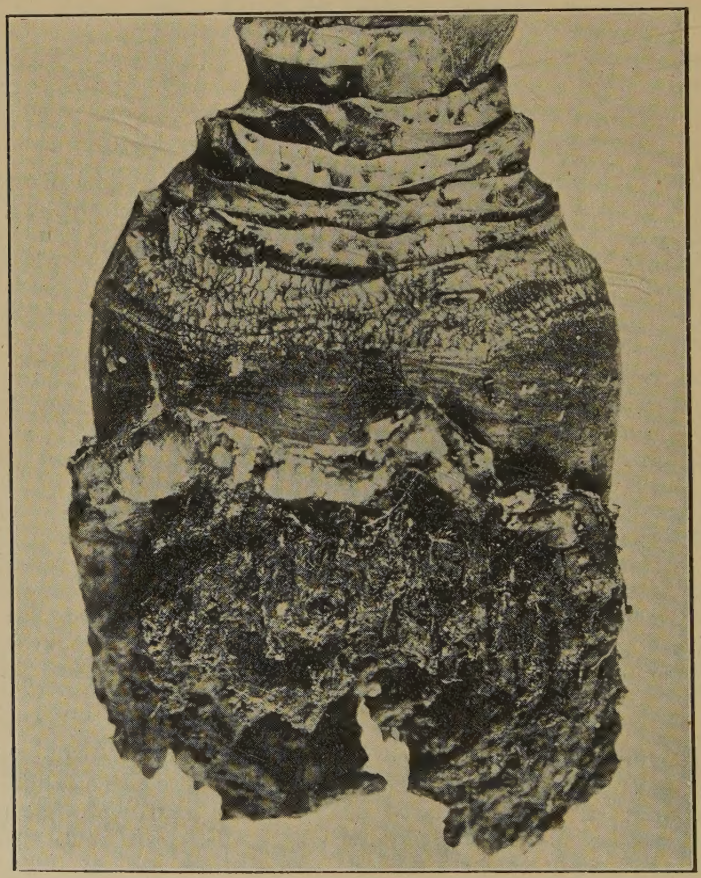


FIG. 1. CLUB-ROOT-INFECTED SWEDE BULB.

Typical specimen showing an advanced stage of the disease.

[Photo by H. Drake.

of the block. The two blocks were planted in exactly the same way in similar soil, nor was any change made in the stock or strength of the inoculum used.

Recent work has indicated that as seed is sown later into the autumn less club-root appears in the resultant crop. This supports the assertion of market-gardeners that club-root is not a menace to the winter crop. The cause of this phenomenon has not been

determined, but the averaged results of small plots of rape sown on different dates in infected soil during the autumn are as follows :—

Table 2.—Effect of Date of sowing Seed on Development of Club-root.

Date of sowing Seed : 1930	3rd February.	17th February	3rd March.	17th March.	31st March.
Number of plots averaged ..	10	10	14	14	14
Average percentage of club-root present, 3rd July, 1930	84	72	55	34	33

Dissemination of the Disease.

That spores may be very easily and unwittingly disseminated over large areas has been amply demonstrated at the Plant Research Station Area. In attempting to inoculate a piece of ground with the dry-rot organism club-root was unintentionally introduced. Even before the disease appeared in the crop special precautions were taken to prevent the spread of either disease from the ground, and men working on the area were instructed to remove all adhering soil from their boots and implements before leaving the plot. The path to the farm buildings followed the banks of a stream and then cut across a piece of ground and past the end of an insectary. When swedes were sown in this latter ground during the following season club-root was noticed along the previous pathway by the stream and by the insectary, but the main area appeared free of infection until a survey was made and all the infected plants plotted on a plan of the area. The whole area was then found to contain approximately 6·6 per cent. of infected plants, while if the areas where infection is heavy are omitted the remainder of the crop shows about 1·4 per cent. of infected plants. The isolated infected plants present throughout the area are probably due to spores having been distributed from the pathways by implements, &c., while the ground was being prepared for the crop, but the infection is so slight that it would not be noticed in an ordinary field-crop unless a special and extensive search were made. (Fig. 2.)

The disease is also known to be spread by surface-drainage water or by flood waters carrying spores from infected to previously clean ground, by carting infected crops out to stock and by diseased refuse being removed to non-infected areas. Earthworms are said to transfer spores among the different layers of the soil([4]), and thus may prevent a complete control by liming through spores being brought from lower levels in acid soil and causing infection of a plant before the lime present in the upper soil layers has had an opportunity of penetrating the soil brought up by the worms. Work in the glasshouse has demonstrated that spores may be carried to a depth of 6 in. in boxes of soil by water applied to the surface of the boxes.

Field observations have led to the suggestion that club-root spores may be seed-borne, but work which has been in progress for eighteen months to demonstrate this point has failed to produce positive results. This work, however, is still being continued.

Through the infection of certain susceptible weeds the club-root organism may, even in the absence of cruciferous crops, live in the

soil for an indefinite period, but if no host is present the spores, judging by Hutt Valley results, do not survive more than from three to four years in the soil.

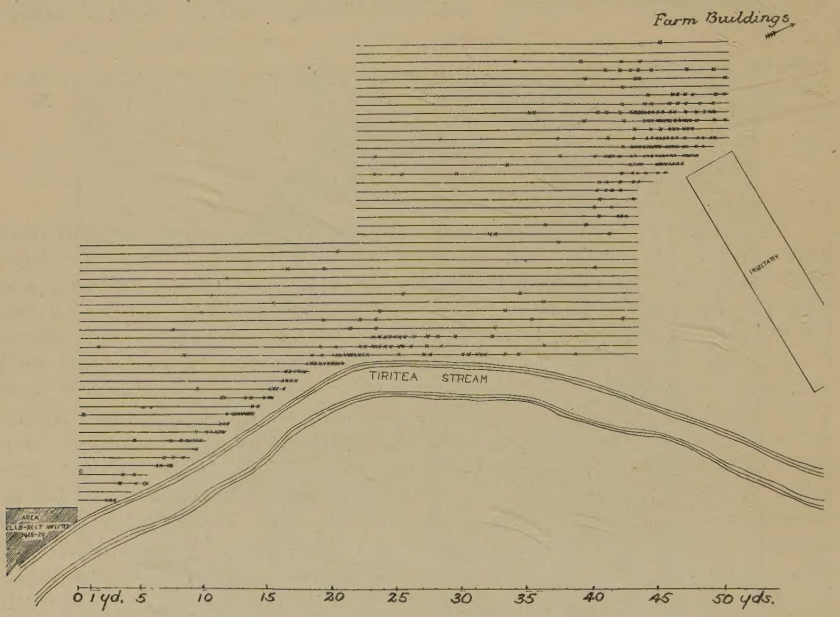


FIG. 2. PLAN OF SWEDE CROP IN 1929–30 AT PLANT RESEARCH STATION AREA, SOWN ON GROUND BELIEVED TO BE FREE FROM CLUB-ROOT ORGANISM.

The lines represent the rows of swedes and each cross (x) marks the position of a club-root-infected swede. The dissemination of club-root along the pathway from the previously infected area is clearly marked. There appears to be another centre of infection near the insectary.

Symptoms.

The first symptom of the disease in a crop is usually seen in the undue wilting of leaves on a warm day. On pulling out a diseased plant the roots are found to be swollen and distorted. Fibrous roots are usually lacking in severe cases of the disease.

With swedes and turnips the disease first attacks the root-system, but later is also seen on the bulbs as more or less coarsely convoluted circular swellings, rupturing and protruding through the epidermis of the bulb. Frequently growth of the bulb makes these lesions appear on its upper surface. Bacteria gain an entrance through these lesions, and cause a rot of the bulb to which the turnip is very susceptible. With swedes the lesion gradually grows and develops a cavity lined with soft, darkened, somewhat fibrous matter, and circumscribed by a light-coloured, raised lip of growing (but infected) tissue, which appears to be an attempt to heal the

lesion. In a more severe case of infection the whole of the root-system may rot off, leaving the base of the swede unsupported on the surface of the ground, and a prey to rot-producing organisms and maggots.

In cases of severe infection of rape the tap-root may swell, become very distorted, fail to produce lateral roots, and finally, through the agency of bacteria, rot off immediately beneath ground-level. The plant is then easily pulled out by browsing stock. If the attack is less severe the disease is often apparent as a tumour-like growth on a side of the tap-root. This tumour subsequently rots off, leaving only a scar in its place.

Chou moellier, though susceptible to club-root, appears capable in most cases of recovering, and the crop is not materially affected by the trouble. Though the whole root-system may be completely infected artificially, the writer and another both searched in a severely infected paddock for one hour and a half and found only twenty plants affected. All these were in contact with infected swedes. An adjoining area of 3 acres of swedes in the same field produced not a single bulb larger than a man's thumb, the whole crop being infected with the organism, while chou moellier matured a good crop 4 ft. high. In these cases where chou moellier was infected the disease usually appeared as a tumour-like growth on the tap-root and later rotted off, leaving a scar in its place.

Cabbage, cauliflower, brussels sprouts, &c., are all extremely susceptible to club-root. In the early stages of the disease the roots become swollen and distorted, and the aerial portions fail to develop normally. Later, through the agency of bacteria, the roots become completely rotted and useless.

There are other lesions which occur on swedes known variously as constitutional nodules or hybridization nodules. These are often confused with club-root by farmers, but so far have not been reported as causing any material loss to swede crops in New Zealand. The nodules may be distinguished from the club-root lesions, as the former are usually, though not always, more or less spherical growths attached to the root or base of the bulb by a very small root-like neck, while the club-root tumours are incorporated within the cortex of the root on which they are present.

In one case where the farmer suspected club-root a decaying state of portions of the swedes submitted was traced to eelworm attack, and no sign of the club-root organism could be observed. Eelworm infection of a number of cruciferous weeds was unintentionally produced in the greenhouse, and resulted in small, definite, isolated swellings from $\frac{1}{20}$ in. high by $\frac{1}{4}$ in. long, or $\frac{1}{10}$ in by $\frac{3}{10}$ in., or more or less circular swellings from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. in diameter.

Host Range.

The writer has found in inoculation experiments that in addition to swedes the following crops are susceptible to the disease: Turnips, rape, thousand-headed kale, buda kale, chou moellier, mustard, cabbage, cauliflower, broccoli, brussels sprouts; also some common cruciferous weeds—namely, shepherd's purse (*Capsella bursa-pastoralis*), wild turnip (*Brassica campestris*), wild cabbage (*Brassica oleraceae*),

wall mustard (*Diplotaxis muralis*), hedge mustard (*Sisymbrium officinale*), narrow-leaved cress (*Lepidium ruderale*), pepper cress (*Lepidium campestre*).

Varietal Resistance of Crucifers.

Although any cruciferous crop may be severely attacked, if not completely killed, by club-root, cabbage and rape appear most susceptible to its attacks, especially in the early stages of growth. On farms soft turnips are frequently sown in preference to swedes where club-root infection is anticipated. This is largely due to the earlier maturation of the soft turnip, which enables it to be fed off

FIG. 3. CLUB-ROOT INFECTION OF CRUCIFEROUS CROP PLANTS.

(1) Superlative swede, (2) Hardy Green Globe turnip, (3) Yellow Tankard turnip, (4) rape, (5) cabbage, (6) buda-kale, (7) chou moellier, (8) thousand-headed kale, (9) mustard. [*Photo by H. Drake.*

before the disease has rendered the crop useless, as often happens with the slower-maturing swedes. The losses caused to swedes and turnips have led to the almost entire replacement of these crops by chou moellier in certain districts. Though severe infection may be artificially induced in chou moellier, the crop is highly resistant in the field, where the yield rarely appears to suffer through club-root attacks.

As a result of observations at Moumahaki in 1911 the Superlative variety of swede was considered to be highly resistant to club-root. This property is not so apparent in the Superlative type of swede at present on the New Zealand market, but there is evidence of strains within the type which do possess a degree of resistance to club-root. Unfortunately, however, these lines cannot be distinguished until the crop is sown in infected ground, and then only when there

is another line sown beside them for comparison. A line of Superlative swede showing such resistance was accidently found at Palmerston North, and selections from the most resistant bulbs are being made.

At present the most resistant swede available in New Zealand is the Danish variety Herning. Trials in Otago and Southland(7) and at Palmerston North have shown that though it is not immune to club-root this swede is decidedly more resistant than the commercial varieties at present on the New Zealand market. The overseas demand for this seed is so great that only limited quantities are available for New Zealand. There is, however, a possibility that a fair supply may be available on the New Zealand market during the coming season. Studsgaard Bangholm swede, from which Herning's is a selection, possesses a certain amount of resistance to club-root infection, and has been procurable in New Zealand for several years. Crimson King swede has been twice recorded in New Zealand as the most susceptible swede to the disease(3)(5).

Among turnips Green-top and Purple-top Yellow Aberdeen have been noticed to show a considerable resistance to club-root infection, the former under field conditions at Gore, the latter under experimental conditions at Palmerston North.

Effect of Manures.

Tests on the effect of manures on the development of club-root have been in progress for one season. In some plots the manure was broadcast previous to sowing the seed, while in others it was sown in contact with the seed. Though no manurial treatment applied controlled the disease, basic slag and sulphate of potash both appeared to reduce the intensity of the resulting infection. The plots that were fertilized with superphosphate, basic superphosphate (15 per cent. slaked lime and 85 per cent. super), and mixtures of super and carbonate of lime (proportions up to 1 to 3 respectively), and super, sulphate of ammonia, and blood-and-bone produced plants more severely infected with club-root than those grown in the unfertilized soil. The growth of the fertilized plants, however, was much better than that of those unfertilized. Further work is being conducted with slag and various manurial mixtures during the present season.

Lime in relation to Control.

Carbonate of lime was intimately mixed with heavily club-root-infected soil in boxes in a glasshouse in an endeavour to control the disease. The soil was about 5 in. deep, and lime was applied at four rates from 1 to 8 tons per acre surface measurement. It was found that when the seed was sown immediately after liming a control was effected only with 8 tons per acre, but when the same boxes were resown with a second crop four months later 3 tons per acre practically controlled the disease in the glasshouse.

Following up this work about five hundred benzine-tins were perforated with small holes for drainage, sunk in the ground, and filled with club-root-infected soil.* Lime of several types was applied to the surface at rates from 1 to 25 tons per acre. The

* These tins are approximately 9 in. by 9 in. by 14 in., and stand 12 in. deep in the ground.

FIG. 4. EFFECT OF LIME ON CLUB-ROOT (1).

Rape plants grown on infected unlimed soil.

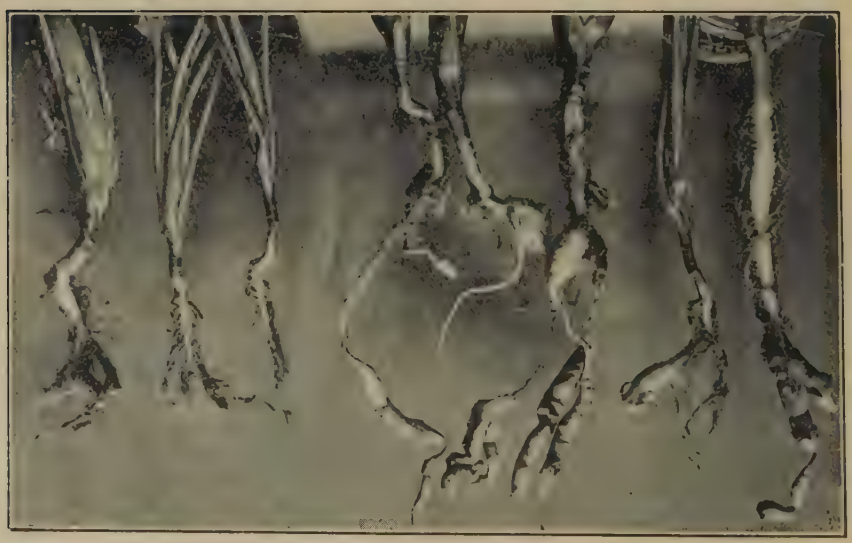


FIG. 5. EFFECT OF LIME ON CLUB-ROOT (2).

Rape plants grown in infected soil to which 3 tons of burnt lime per acre was applied eighteen days before sowing the crop. The photo shows typically clean and diseased plants, and does not indicate the percentages of these.

[*Photos by H. Drake.*

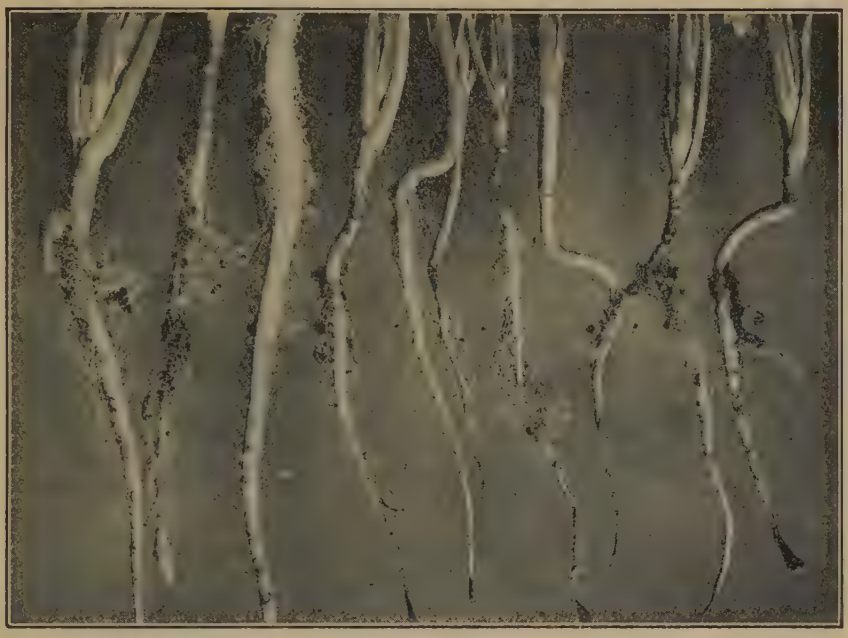


FIG. 6. EFFECT OF LIME ON CLUB-ROOT (3).

Rape plants grown in infected soil to which 20 tons of burnt lime per acre was applied four days before sowing the crop. Three centres of infection are visible.

FIG. 7. EFFECT OF LIME ON CLUB-ROOT (4).

Rape plants grown in infected soil to which 3 tons of slaked lime per acre was applied three months before sowing the crop. One infected plant is shown.

[*Photos by H. Drake.*

types of lime used comprised freshly burnt, freshly air-slaked, freshly water-slaked, commercial ground rock ($CaCO_3$), and a specially finely ground carbonate of lime (75 per cent. passing 200-mesh sieve). The results of this experiment are not yet complete, but sufficient information has accumulated to show that club-root may be controlled by liming on the soil under experiment.

Whether lime affords a commercially practical control is still to be determined. Burnt lime or either of the slaked limes appears equally effective in control of the disease, but the commercial carbonate appears of very little use when applied at quantities less than 10 tons per acre. It also appears that the controlling influence of lime is not evinced immediately on its application to the soil. An application of 25 tons per acre of burnt lime did not control the disease until after a fortnight had elapsed, but a satisfactory control was effected with 2 to 3 tons of burnt lime applied three months before sowing the crop. It is probable that the quantities of lime necessary will vary according to the soil-types, and the determination of the minumum quantity and time of application which will effect a control of the disease is still the subject of investigation.

Projected Work.

Projected work and work in hand is designed to determine the longevity of spores under dry and soil conditions, and whether the disease is seed-borne. The work concerning effect of manures on club-root is also being continued, and small lime plots are being laid down under field conditions. Selections of seed from club-root-resistant lines of rape, swede, and turnip are to be made, and further work prosecuted to determine the extent of weed hosts of club-root in New Zealand. In the glasshouse, work is being conducted to test the effects of disinfectants and heat on the death-point of spores, and also the effects of soil-types on the development of the disease.

Recommendations for Control.

These recommendations are based on preliminary experimental evidence, and are offered tentatively to relieve a serious position. No method of complete control suitable for practical application on a farm has yet been evolved, but the knowledge of means of dissemination, the eradication of weed hosts which enable the disease to persist while a cruciferous crop is not in the ground, and the use of club-root-resistant lines of swedes and turnips should effect a marked reduction in the severity of the disease. If slag and potash are used as fertilizers a further reduction of club-root should be effected, but manures containing superphosphate, sulphate of ammonia, and basic super are likely to increase the incidence of the disease.

The most hopeful line of field control rests in lime, and if sufficient of this can be applied to "*neutralize the soil-acidity and leave a moderate excess of free lime in the soil*"(9) no fear of severe losses from the disease need be entertained. Burnt lime or a freshly slaked lime offers the only hope of producing this result at an economical cost, and even then must be applied well in advance of the date of sowing the crop. The work has not yet proceeded sufficiently to indicate what quantity will effect this action in the soil, but it is thought that—on certain soils, at any rate—two or three annual dressings of burnt lime at 1 ton per

acre should prove sufficient, or from 2 to 3 tons per acre worked into the soil about three months before sowing the crop.

Where the crops grown are of high per-acre value, such as are produced by market gardeners, liming to the extent necessary to control the disease would appear to be reasonable; but in the case of ordinary farm brassica crops much yet remains to be done from the standpoint of soil and climate in relationship to the disease before the economics of liming for its control can be determined.

Summary.

(1) A summary of a survey of club-root in various districts of Wellington, Hawke's Bay, and Taranaki Provinces is given and discussed.

(2) Field evidence indicates that the longevity of *P. brassicae* spores in the soil is from three to four years.

(3) Preliminary work shows that club-root infection is influenced by the spore load, but that there is no simple correlation between the two.

(4) No evidence has been obtained of the existence of biological strains of *P. brassicae*.

(5) Club-root develops less readily in autumn-sown than in spring-sown crops.

(6) All efforts to isolate the club-root organism from the seed have failed.

(7) Dissemination, symptomatology, and host range of the disease in New Zealand are given.

(8) Partially resistant crops are mentioned and discussed.

(9) Some effects of manure and lime on the disease are briefly given.

(10) Suggestions for control consist of (*a*) the application of from 2 to 3 tons of burnt lime per acre three months before sowing the crop; (*b*) the use of resistant crop varieties or strains where possible; (*c*) the use of basic slag as a phosphatic fertilizer wherever slag gives a good response on brassica crops.

References.

(1) Bremer, H. Investigations on the Biology and Control of the Causal Organism of Club-root of Cabbage, *Plasmodiophora brassicae* Wor. (Translation of German title). Second Note, Club-root and Soil Acidity. *Landw. Jahrb.*, Vol. 59, pp. 673, 685, 1924. Abstr. in *Rev. of App. Myc.*, Vol. 3, p. 620, 1924.

(2) Chupp, Charles. Club-root in Relation to Soil Alkalinity. *Phytopath.* Vol. 18, pp. 301, 306, 1928.

(3) Deem, J. W. Marton Experimental Area. *N.Z. Jour. of Agric.*, Vol. 33, p. 118, 1926.

(4) Gleisberg, W. The Mystery of the Dissemination of Club-root. (Translation of German title.) *Nachrichtenbl. Deutsch. Pflanzenschutzdienst*, Vol. 2, pp. 89–90, 1922, Abst. in *Rev. of App. Myc.*, vol. 2, p. 351, 1923.

(5) Hudson, A. W. Swede Variety Trial in Canterbury. *N.Z. Jour. of Agric.*, Vol. 33, p. 189, 1926.

(6) Monteith, J., jun. Relation of Soil Temperature and Soil Moisture to Infection by *Plasmodiophora brassicae*. *Jour. Agric. Res.*, Vol. 28, pp. 549–561, 1924.

(7) Tennent, R. B. Club-root in Turnips: Ten Years' Investigation in Otago and Southland. *N.Z. Jour. of Agric.*, Vol. 40, p. 51, 1930.

(8) Wellman, F. L. Club-root of Crucifers. Tech. Bull. No. 181, U.S. Dept. of Agric., pp. 1–31, 1930.

(9) Wilkins, V. E. Research and the Land, London, 388 pp., 1927. Ref. on page 198.

MINERAL FEEDING EXPERIMENTS.

IODINE, LIME, AND SALT-LICK QUESTIONS.

B. W. SIMPSON, Chemistry Section, Department of Agriculture (on loan from Rowett Research Institute, Scotland).

1. Effect of Iodine Intake on Growth.

THE object of this experiment was to obtain local data on iodine and animal growth, the work being carried out at the Chemical Laboratory of the Department of Agriculture, Wellington.

Twelve young rabbits were divided into three groups, four in each. The first group was fed on a basal ration without additional iodine; the second group received the basal ration with added iodine in the form of an inorganic salt; the third group was given additional iodine by increasing the iodine content of the green food, the soil on which this food was grown being manured with the same inorganic salt as used for the second group.

The basal ration consisted of hay and pollard grown locally. Green food consisting of silver-beet, lucerne, and clover was added to this ration. A small plot of ground, obtained for growing this food, was divided into two parts. One part was watered with a weak solution of biniodate of potassium before the plants were put in; the other part had no iodine. Silver-beet seeds were germinated in boxes in the beginning of August and then planted out. Half of the seeds were soaked in a biniodate solution first.

The plants assimilated the iodine. The amount assimilated varied with the species, as has also been observed by Scharrer and Strobel (*Angew. Botanik.*, 9, 1927). These workers reported the following results, showing that lucerne assimilated more iodine than the other two:—

Table 1.

Plant.	Control.	0·5 mg. Iodine per Experimental Pot.	1·0 mg. Iodine per Experimental Pot.
	Gammas per 100 grammes.	Gammas per 100 grammes.	Gammas per 100 grammes.
Lucerne	56	130	575
Red clover	63	125	200
Oats (straw)	36	60	205

In the Wellington feeding experiment the dosage of iodine used was 300 mg. iodine for a 10 square yard plot. The silver-beet seeds used had an original iodine content of 37 gammas* per 100 grammes. The amount of iodine assimilated at various dates by different plants is shown in Table 2. It will be seen that the lucerne had assimilated more iodine than the silver-beet or spinach sampled on the same date.

* A gamma (γ) equals one-millionth part of a gramme.

Table 2.—Iodized Plot.

Plant.	Date.	Iodine Content in gammas per 100 grammes Dry Weight.
Silver-beet	2/1/30	916
White clover	12/2/30	559
Silver-beet	1/7/30	550
Lucerne	30/9/30	530
Silver-beet	15/10/30	127
Lucerne	15/10/30	437
Perpetual spinach	15/10/30	229

Table 3.—Uniodized Plot.

Plant.	Date.	Iodine Content in gammas per 100 grammes Dry Weight.
Silver-beet	2/1/30	92
Lucerne	12/2/30	31

Group 1 was fed hay and pollard, together with silver-beet, lucerne, and clover from the uniodized plot. Group 2 was fed hay and pollard with silver-beet, lucerne, and clover from the iodized plot. Group 3 was fed hay and pollard, with silver-beet, lucerne, and clover from the uniodized plot, plus 5 mg. of iodine per day per rabbit in the form of biniodate of potassium solution added to the pollard, which for every group was made into a mash with ordinary tap water. Each group received tap water as well.

The rabbits were obtained on 6th December, 1929, and fed on the same ration for a pre-experimental period till the 20th of that month, when group feeding was begun. This was continued till April. In the beginning of March the fur was markedly poor in Group 2, but these rabbits quickly regrew the fur, and at the beginning of April had fine coats. Group 3 had the best fur all through the experimental period. In March the bucks were separated.

Graph 1 shows the average percentage increase on the weights at the beginning of the experimental period. The weights, increase, and percentage increase were as follows:—

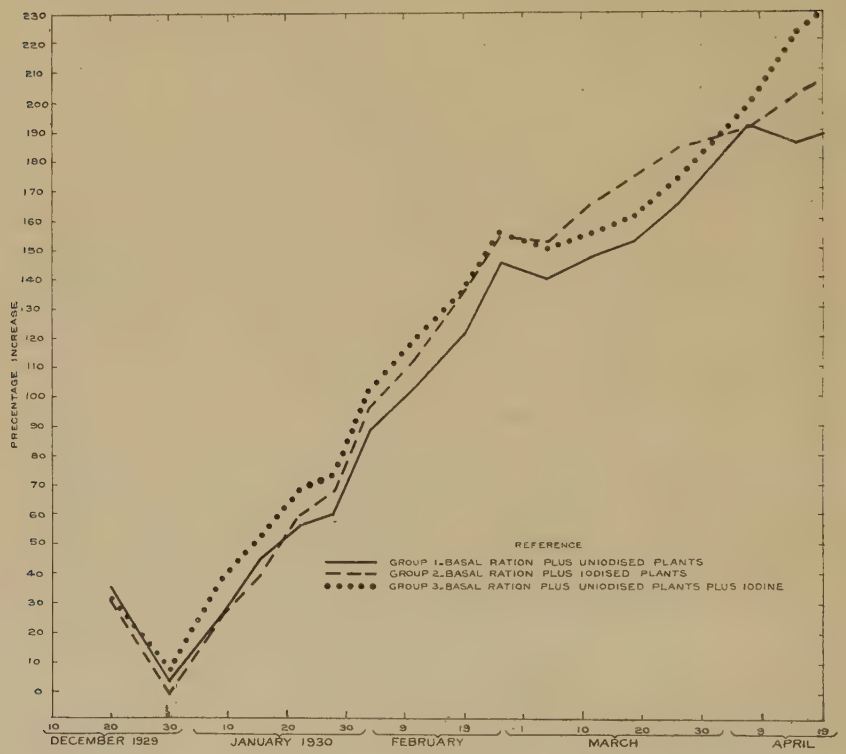
Table 3.

Group.	Average Initial Weight.	Average Final Weight.	Average Increase.	Percentage Increase.
	Oz.	Oz.	Oz.	
1.. ..	22·4	64·5	42·1	187·9
2.. ..	19·9	60·8	40·9	205·5
3.. ..	20·0	65·7	45·7	228·5

SUMMARY.

The addition of iodine to food grown in the Wellington area and fed to young rabbits improved their rate of growth. As the Wellington area is not such a reputed goitrous area as certain other parts of New Zealand a marked effect on the rate of growth was not

obtained, but the percentage increase of growth was distinctly greater in the two iodized groups than in the control group.



GRAPH I.—SHOWING AVERAGE PERCENTAGE INCREASE IN WEIGHT OF RABBITS (IODINE FEEDING EXPERIMENT).

2. Excess of Lime in Diet and Incidence of Goitre: Suggested Relationship disproved.

The object of this experiment was to ascertain if there is a causal relationship between excess of lime in the diet and the incidence of goitre. In 1929 an investigation was made by the Department into the cause of a high mortality among lambs on certain areas near Lake Wanaka. These lambs were underdeveloped, had a comparative absence of wool (the wool being replaced by coarse hair), were overshot at the knees, had badly formed brittle hoofs, and enormous enlargement of the thyroid glands (see this *Journal* for April, 1930). It was suggested that these large glands might have been due to excess of lime in the diet, or to the feeding of a lick containing Kerol, salt, lime, sulphur, bone-meal, and rock phosphate, superimposed on a diet low in iodine. A small experiment on rabbits fed on a basal ration grown in the affected area, with lime and the salt lick superimposed, was therefore carried out at the Chemical Laboratory.

Twelve rabbits born and bred in the Wellington area were divided into three group of four rabbits each. Group 1 was fed the basal ration of hay, turnips, and pollard mash, all grown in the goitrous Wanaka area. Ordinary Wellington tap water was used for all groups. Group 2 was fed the basal ration, plus 1 gramme of lime daily from a large deposit at Wanaka. Group 3 was fed the basal ration, plus 1 gramme daily of the salt-lick fed to sheep on the affected area.

The pollard contained 30 gammas of iodine per 100 grammes dry weight. A second supply of pollard had 50 gammas per 100 grammes. Wanaka turnips contained 28 gammas, and Wanaka hay had 25 gammas. There was no iodine in the lime, but the salt-lick had 12 gammas per 100 grammes dry weight. For comparison with these figures, Wellington (Wallaceville) pollard contained 80 gammas per 100 grammes, and hay 153 gammas. The lime had a trace of phosphate in it. The salt-lick had an average percentage of 4 per cent. phosphoric acid (P_2O_5).

The mineral content of the Wanaka hay (in November) is shown by the following table :—

Table 1.

Iodine (I).	Phosphoric Acid (P_2O_5).	Lime (CaO).	Chlorine (Cl).	Magnesia (MgO).	Sodium (Na_2O).	Potassium (K_2O).
Gammas per 100 grammes.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
13γ ..	0·65	2·5	0·35	0·83	0·07	3·9

Nitrogen (N).	Iron (Fe).	Manganese (Mn).	Silica (SiO_2).	Alumina (Al_2O_3).	Ash.
Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
4·8	0·03	0·007	0·61	0·05	11·6

The lime content is very high ; sodium, chlorine, and iodine are low.

The growth of the rabbits in the three groups is shown in the next table.

Table 2.

Group.	Average Initial Weight.	Average Final Weight.	Average Increase.	Percentage Increase.
	Oz.	Oz.	Oz.	
1	21·00	46·1	25·10	119·5
2	21·25	45·1	23·85	112·0
3	18·20	44·5	26·30	144·0

Graph 2 (page 23) shows the average percentage increase in weight of the three groups. The group which received the salt-lick improved steadily.

The weights and iodine content of the thyroid glands of the rabbits in the three groups are given in Table 3.

Table 3.

Weight of Rabbit.	Weight of Thyroid.	Iodine Content of Thyroid.	Percentage of Iodine.
	Group 1.		
Oz.	Grammes.	Gammas.	
44·5	0·2505	7·2	0·0029
50·5	0·2155	12·7	0·0059
42·0	0·2655	3·4	0·0013
47·5	0·2575	10·6	0·0041
	Group 2.		
47·5	0·2045	5·9	0·0029
47·5	0·1855	11·8	0·0064
47·0	0·1855	7·2	0·0039
38·5	0·2285	6·3	0·0028
	Group 3.		
36·0	0·1155	5·9	0·0051
49·0	0·1495	13·1	0·0088
47·0	0·1505	6·3	0·0042
47·0	0·1515	7·6	0·0050
43·5	0·1855	3·4	0·0018*

* This animal was subject to fits.

Data for comparison with these figures are rather meagre, but the following are of interest: In the first experiment a rabbit in Group 3 (fed 5 mg. biniodate of potassium per day) had a thyroid weighing 0·1020 grammes. The total iodine was 34 gammas and the percentage iodine 0·033 gammas. This animal weighed 73 oz. Another rabbit weighing 60 oz., in Group 2, fed with iodized plants, had a thyroid with a total iodine content of 14·5 gammas. Two wild rabbits about six weeks old from Blenheim had thyroids weighing 0·1210 grammes and 0·0500 grammes, with an iodine content of 5·7 gammas and 5·9 gammas, or 0·0047 and 0·0118 per cent. iodine respectively. Hercus found 0·016 per cent. iodine in a rabbit's thyroid; the Rowett Research Institute found from 0·023 to 0·05 per cent. iodine, and in this Laboratory we (unpublished data) have found in two rabbits fed on Wallaceville hay and turnips, and weighing 35 oz. and 43 oz., thyroids weighing 0·085 grammes and 0·147 grammes, containing 54 gammas and 123 gammas, or 0·06 and 0·08 per cent. iodine respectively.

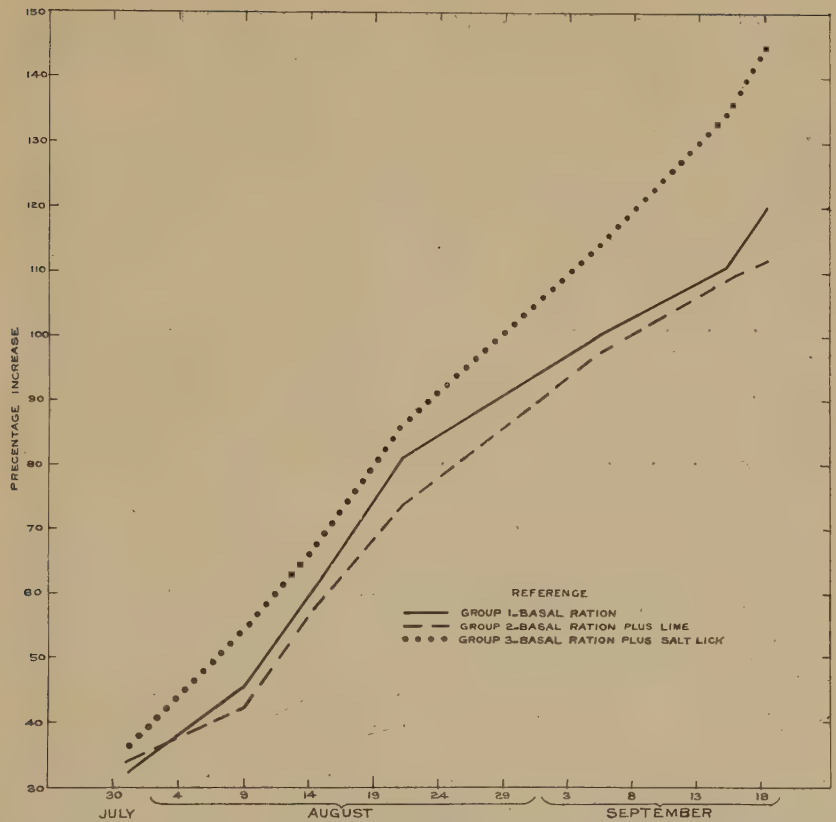
Results from rabbits fed on hay, pollard, and turnips from a non-goitrous area (Upper Hutt) are given in Table 4.

Table 4.

Weight of Rabbit.	Weight of Thyroid.	Iodine Content.	Percentage of Iodine.
Oz.	Grammes.	Gammas.	
35	0·085	54	0·06
43	0·147	123	0·08

Summary.

The result of this experiment is definite. The lime added to the ration, either alone or in the form of a salt-lick, did not cause the thyroid gland enlargements. The lime alone had little effect on the



GRAPH 2.—SHOWING AVERAGE PERCENTAGE INCREASE IN WEIGHT OF RABBITS (LIME AND SALT-LICK EXPERIMENT).

average size of the glands or on the rate of growth of the rabbits. The lick increased the rate of growth of the animals and reduced the size of the glands. A simple lick containing iodine, salt and phosphorus is needed in the affected areas (near Lake Wanaka and at Makarora).

The basal ration in this experiment was already very high in lime (2·5 per cent. in the hay). The phosphate content of the hay was low (0·65 per cent.). Group 2 had a trace of phosphate in the added lime. Group 3 had about 4 per cent. phosphate in the salt lick. Group 3 also had a small quantity of iodine daily more than the others, and an amount of sodium chloride far in excess of the other two groups. Which of these three ingredients in the salt-lick effected the improvement in growth and reduction in the size of the thyroid glands will be investigated by means of a further experiment.

The peculiar point that emerges from this experiment is that large glands with a very low iodine content have been produced by feeding animals with food grown on a goitrous area.

FRUIT EXPERIMENTATION IN NEW ZEALAND.

CO-OPERATIVE PLAN INAUGURATED.

J. A. Campbell, Director, Horticulture Division, Department of Agriculture.

For some time past the Horticulture Division of the Department of Agriculture has been desirous of having an experimental officer made available for the purpose of investigating certain orchard diseases, and for arranging and co-ordinating spraying and other experimental work undertaken by the Department in different parts of the Dominion. A short time ago definite steps to this end were taken, and Mr. W. K. Dallas, Orchard Instructor for Otago, was appointed. Mr. Dallas has been seconded to the Mycological Laboratory of the Plant Research Station, Palmerston North, to act as a connecting-link between the practical and scientific phases of fruit-culture, in pursuance of a research scheme to be conducted by the Horticulture Division, Dr. G. H. Cunningham, and other scientific officers of the Station.

An outline of the scheme was placed before the executive committee of the New Zealand Fruitgrowers' Federation by the writer and Dr. Cunningham, and the Federation was invited to co-operate. This the Federation was only too pleased to do, being of the opinion that such a scheme would be of immense value to the fruit industry, not only in placing research investigations on sound lines, but in serving as a ready means of extending to the various fruitgrowing districts of the Dominion the researches undertaken by the Fruit Research Committee of the Department of Scientific and Industrial Research.

With a view to ensuring to the greatest possible extent the assistance and co-operation of all interests concerned, the following arrangements have been devised: A controlling committee, composed of principal officers of the Horticulture Division, Plant Research Station, and Fruitgrowers' Federation executive, has been set up to generally supervise the work. All the scientific officers of the Plant Research Station will act as a consultative committee in conjunction with Dr. Cunningham and Mr. Dallas, while Mr. A. W. Hudson, Crop Experimentalist, will have control of all manurial experimental work. These officers will investigate all orchard problems submitted, and will devise a research programme in connection therewith prior to the commencement of each season. This will be submitted to the main committee for approval or amendment as the case may be.

The Fruitgrowers' Federation will seek the co-operation of all district fruitgrowers' associations, and in localities where experiments are to be carried out the associations will be requested to set up a small district sub-committee. This committee, with the local Orchard Instructor, who will be convener and chairman, will take over the supervision of any experimental work proposed to be conducted in the district, under Mr. Dallas, who will have general charge of such work.

The functions of district fruit experimental sub-committees will be as follows:—

(1) The sub-committees of the respective associations will communicate any proposals or other communications which they may

wish to make through the usual channels to the manager, New Zealand Fruitgrowers' Federation, Wellington.

(2) Arrange with local orchardists whose places are considered suitable for the respective experiments for the use of their orchards or any portion thereof for the purpose of carrying out the experiments.

(3) Arrange for the necessary labour, and such requisite plant as may be possible for carrying-out of work in connection with investigations.

(4) The Orchard Instructor will supervise the laying-down of all experiments and other work which may be necessary for the success of the experiment throughout the whole period of the investigation. He will also be required to inspect regularly the plots of each experiment under his supervision, and to fully record the progress and results obtained in connection with the tests.

The following illustration will indicate how the scheme is intended to work in practice: A fruitgrower or a number of growers are of the opinion that certain experimental work is necessary to discover, say, a more efficient and economical method of controlling brown-rot than the methods at present in use. The matter will be brought before the local fruitgrowers' association and referred to the district fruit experimental sub-committee, which will consider the matter, and state whether in its opinion the matter is one that should be investigated. The sub-committee should supply a brief report as to the approximate economic loss which the disease is causing in its district, the kinds and varieties of fruit-trees affected, what control measures have been tried and with what result, and, generally, any information likely to be of value in planning the experimental work.

The request for an experiment to be carried out, together with the data outlined above, is to be forwarded to the manager of the Fruitgrowers' Federation, Wellington. He will place the request before the special committee for its consideration, and if it approves of the experiment being conducted it will direct that the request be forwarded to the Plant Research Station. It may happen that the experiment asked for is being carried out in other parts of the Dominion, and in such case the special committee will be called on to decide whether a further replication of the same experiment is desirable. Should it decide that the experiments in progress are sufficient for the time being, it will notify the association concerned of the position.

In such case the Plant Research Station will prepare a complete programme of work to be undertaken, together with a plan of the layout of the various plots connected with the experiment, kinds of material, quantities required, and their approximate cost. The programme will then be returned to the main committee for final approval.

A copy of the programme will be forwarded to the Director of the Horticulture Division, the manager of the Fruitgrowers' Federation, and the Orchard Instructor for the district concerned. On receipt of the programme the manager of the Federation will forward a copy to the association, whose district fruit experimental sub-committee will take steps to initiate the experiment according to the plan laid down, and under the direction and supervision of the Orchard Instructor for the district. The Orchard Instructor will inspect

the plots regularly, take written notes of the progress of the experiment, recording work done since last visit, results obtained, condition of trees, and of any other matters relative to the experiment which will enable him to prepare full interim reports and a final report. Copies of the Instructor's reports are to be forwarded to the Plant Research Station and the Director of Horticulture. The Plant Research Station, at the conclusion of an experiment, will carefully study and analyse the data submitted, and supply a full report on the experiment to the Director of Horticulture and the manager of the Fruitgrowers' Federation, who will in turn arrange to give it suitable publicity for the information of growers.

The division of effort and expense in connection with the scheme will be along the following lines: The Department of Agriculture to provide the services of its officers and all costs by way of salaries and travelling-expenses incurred by them, as well as expenditure required for equipment, &c. The Federation to be responsible for spraying and other testing materials. Associations to be responsible for such local expenses as the cartage of material, supply of implements or plant, and such labour as may be necessary in connection with experiments in hand.

The scheme outlined has now been actually put into operation, and a large programme of experimental work for the season already commenced. This includes the control of brown-rot and powdery mildew, and the elimination of russeting, &c.; while a number of new spraying ingredients are being tested and new formulas tried out with a view to increasing general spraying efficiency. The programme also includes extensive cool-storage investigations, with a view to correlating evidence relative to the fungal rotting of fruit in storage. Several orchard manurial tests, which will run for several years, have also been established. The scheme has been designed to obtain the greatest amount of co-operation on the part of all concerned by securing their direct interest in the conduct and control of the work.

NOTE.—The foregoing scheme of experimentation should not be confused with the work of the Fruit Research Committee of the Council of Scientific and Industrial Research. The scheme is a co-operative one between the Department of Agriculture and the fruitgrowers of the Dominion — through their organizations, the Fruitgrowers' Federation, and local associations — and will be directly concerned with experimental work in the various districts. The whole of the work, however, will be conducted in close association with the Fruit Research Committee (of which the writer is a member), and, where it touches the Nelson District, will, so far as practicable, be carried out in the research orchard recently established there. The work in that case will practically become a part of the Research Committee's activities.

Inspection of Milking-machines.—Special attention was given by the Dairy Division to the inspection of new and renovated milking-plants installed during the past year. This service is much appreciated by both the users and the makers and their agents. Little or no difficulty has arisen in connection with the enforcement of the regulations bearing on this matter.

MARTON EXPERIMENTAL AREA.

NOTES ON OPERATIONS, SEASON 1929–30.

W. J. McCULLOCH, Fields Superintendent, Palmerston North.

THE work of the Marton Experimental Area may be claimed to have increased in value each succeeding year as the production of grassland has become more and more recognized to be the chief factor underlying primary production in New Zealand. During late years very profitable and interesting work in connection with top-dressing, strain trials of rye-grasses and clovers, and other phases of pasture-management has been gradually building up. This, together with the more recent development of intensive grassland research on the area by specialist officers, is accumulating further valuable knowledge, which, as formerly, is being disseminated by practical demonstrations for the benefit of farmers, the seed trade, and others concerned.

With regard to seasonal conditions in 1929–30, the autumn and early winter period was mild and fairly dry, consequently the heavy clay subsoil did not cool down early and growth continued fairly late. The autumn sowings of rye-grass strain trials in Field 1 thus had every opportunity of becoming well established. In June (1929) the dry spell was broken, and moist conditions continued until October, after which pasture growth came on with a rush. The rainfall for the twelve-month was within the average of the Marton district for the past twenty-two years.

RYE-GRASS STRAIN TRIALS.

In the autumn of 1929 an area of 15 acres was laid down under the care of Mr. E. Bruce Levy, Agrostologist, in rye-grass strain trials. The test comprises 620 plots of strains selected from the chief seed-growing districts of the North and South Islands.

The whole area has been grazed by sheep under normal conditions, and the different types stand out prominently in varying degrees of growth-habit and persistency, and have proved of extreme interest in demonstrating the value of the true perennial strains as against the non-persistent false perennial and Italian types. The tendency of the two latter types to rust was very marked, the true perennial appeared immune. An interesting feature was the preference shown by stock for the more temporary types; these were grazed exceptionally close, but it has been noticed that the reverse is the case later in the season if growth is allowed to get away a little. Already in the first season the sward has opened up badly in the non-persistent plots, and is being invaded by a certain amount of volunteer white clover and weeds.

Standard Canterbury rye-grass sown in November, 1926, has proved to be a non-persistent type which has completely died out. Hawke's Bay rye-grass sown at the same time has proved to be a persistent type which still continues a very good sward.

RYE-GRASS AND WHITE CLOVER STRAIN TRIALS.

In plots sown in April, 1927, Hawke's Bay rye continues extremely good, and is proving the permanency and general good qualities of this

strain. The Canterbury rye is nearly all gone—replaced by flat weeds and an increase of dogstail. In a trial laid down in April, 1928, Hawke's Bay rye continues very good, and shows up in marked contrast to adjoining strains; Sandon and Canterbury standard ryes are about equal, but already both are rapidly deteriorating and the sward is becoming weedy. Wairarapa old-pasture white clover sown in conjunction with these three rye-grasses is proving a good strain.

White Clover Strain Trials.

In sowings made in April, 1926, the genuine imported wild white clover is still continuing to do splendidly, being very persistent. The Marton-area-grown seed of wild white is likewise continuing to do well and demonstrating its persistency. Whybourne's wild white has shown itself to be a most excellent type, with fairly large vigorous leaf, capable of rapid recovery after grazing and a very early spring grower, also very persistent. The Canterbury white clover has apparently died out and the Marlborough white has completely disappeared.

As regards trials sown down in December, 1925, Kentish wild white clover is still doing well and proving very persistent. The Canterbury white clover has proved to be a good strain and is still persisting, but not quite so good as the Kentish. The Dutch imported white has completely gone, being replaced by a sward of brown-top.

In plots sown in December, 1924, the Canterbury white clover has nearly all gone, the ground being filled up with rye-grass and annual poa. The Kentish wild white is still covering the ground fairly well, although rye-grass and annual poa are also much in evidence.

Control of Rushes in Pasture.

Between two plots of white clovers running through the centre of a field a plot ½ chain in width was sown at the same time in Phalaris bulbosa, but was evidently a poor strike. Through poor competition, and the consequent neglect of stock, this strip became thickly infested with a small type of rush common to the locality. The whole plot was top-dressed with phosphates in July, 1928, and half the area was mowed in the following October. The whole was again manured in August, 1929, and the same half mowed again in March, 1929.

It is significant that manuring without mowing is useless in the eradication of rushes, but that a combination of both appears to have effected very good results. The removal of the rush-growth by mowing has allowed the light in to the sward, and this together with manuring, has sweetened the pasture and encouraged volunteer rye-grass and white clover. Hence the entrance of stock and good grazing, while on the half not mown, although manured, rushes continue to monopolize the ground, and in consequence it is neglected by stock.

Manures were applied on individual plots at the rate of 3 cwt. per acre with the following results: (1) slag, best grazed, rushes almost gone; (2) super, next best grazed, rushes nearly all gone; (3) Seychelles phosphate, nearly equal to super; (4) Nauru phosphate, not quite so good as No. 3.

Pasture Top-dressing Experiments.

In previous reports on work at Marton particulars have been given of top-dressing experiments carried out on sections of the Area known as Moss's, Brice's, and Follett's. The following tables bring the information up to the end of the 1929–30 season :—

Table 1.—Moss's Section (Field 4A).

Plot No.	Treatment per Acre.	Green Weight per Acre—One Cut, 1929.	Total Green Weight per Acre—One Cut annually, Five Years.	Increase over Average of Controls for Five years.
		Tons.	Tons.	Tons.
1	Carbonate of lime, ½ ton, 27/7/25; repeated, 1929	2·2	7·78	0·26
2	Carbonate of lime, ½ ton, 27/7/25; super, 27/7/25, 28/5/26, 23/7/28, 15/8/29	6·3	21·93	14·41
3	Super, 3 cwt. (Dates applied same as for Plot 2)	6·7	21·73	14·21
4	Basic super, 3 cwt. (Dates applied same as for Plot 2)	3·8	15·86	8·34
5	Basic slag, 3 cwt. (Dates applied same as for Plot 2)	4·6	22·04	16·52
6	Nauru phosphate, 3 cwt. (Dates applied same as for Plot 2)	4·4	19·84	12·32
7	Super and blood-and-bone, 3 cwt., in equal parts. (Dates applied same as for Plot 2)	4·5	17·38	9·86
8	Same as for Plot 7, plus ½ cwt. sulphate of potash. (Dates applied same as for Plot 2)	5·3	20·27	12·75
9	Super, 3 cwt., 27/7/25, 28/5/26, 23/7/28, 15/8/29; nitrate of soda, 1 cwt., 7/10/25, 13/10/26	7·5	28·19	20·67
..	Average of controls left between each plot	1·92	7·52	..

Table 1A.—Moss's Section—continued.

Plot No.	Treatments applied transversely over the Nine Phosphate-dressed Plots shown in Table 1.	Green Weight per Acre—One Cut, 1928.	Green Weight per Acre—One Cut, 1929.	Total Green Weights, Two Years.
		Tons.	Tons.	Tons.
10	Nitrochalk, 1 cwt., 22/7/28, 19/10/29 ..	4·94	4·5	9·44
11	Sulphate of ammonia, 1 cwt., 22/7/28, 19/10/29	4·25	4·1	8·35
12	Nitrate of soda, 1 cwt., 22/7/28 (none, 1929)	4·25	3·3	7·55
13	30 per cent. potash salts, 1 cwt., 28/7/26, 23/7/28, and 1929	3·26	2·8	6·06
14	Muriate of potash, ½ cwt., 23/7/28 and in 1929; kainit, 2 cwt., 27/7/25, 28/5/26	3·0	3·2	6·2
..	Average of controls	3·77	3·44	7·13

Some of the striking features of this experiment are :—

(1) The slightly heavier production of herbage (in weight) by slag over super for five years, probably due to the greater influence on the density of clovers and general thickening of the bottom.

(2) The greatly increased weight produced by the addition of nitrate of soda to super, as a result of great stimulation of grass, particularly cocksfoot.

(3) The steady and good general effect of Nauru phosphates which appears to suit this heavy clay loam.

(4) The addition of ¼ cwt. sulphate of potash to blood-and-bone, as compared with blood-and-bone alone, appears somewhat conflicting when compared with potash results on the transverse plots. This requires further investigation.

(5) The disappointing results from basic super as compared with slag, Nauru, and the combination of super and lime and super alone.

(6) The disappointing yield from blood-and-bone in relation to the high cost of this manure.

(7) The recovery of the aftermath and consequent palatability, as shown by the preference of stock, is in about the following order of merit: Super plus lime, with slag and super each close up, and Nauru rather good; others are much inferior; lime alone indicates a little attention from stock.

(8) The addition of potash on transverse strips is disappointing, likewise nitrate of soda, but sulphate of ammonia and especially Nitrochalk show a good advance in herbage production.

(9) The building-up values of the different treatments over a period of five years.

Table 2.—Brice's Section (Field 3A).

Plot No.	Treatment per Acre.	Green Weight per Acre—One Cut, 1929.	Total Green Weight per Acre—One Cut annually, Six Years.	Increase over Average of Control for Six Years.	Average Increase per Year over Control.
		Tons.	Tons.	Tons.	Tons.
1	Carbonate of lime, 1 ton, 9/8/21; super, 2 cwt., 9/8/21, 11/8/24, 28/5/26, 15/8/29	7·4	37·43	28·47	4·74
2	Bone-char, 4 cwt., 9/8/21; Nauru phosphate dust, 4 cwt., 11/8/24, 28/5/26, 15/8/29	7·8	36·61	27·65	4·60
3	Walpole phosphate, 4 cwt., 9/8/21; Nauru phosphate, 4 cwt., 11/8/24, 28/5/26, 15/8/29	8·5	39·08	30·12	5·02
4	Nauru phosphate, 4 cwt., 2/11/22, 11/8/24, 28/5/26, 15/8/29	7·3	36·5	27·54	4·59
5	Control	2·6	8·96	..	..
6	Basic slag, 4 cwt., 14/7/21, 11/8/24, 28/5/26, 15/8/29	5·5	28·8	19·84	3·30
7	Nauru phosphate, 4 cwt., 14/7/21, 11/8/24, 28/5/26, 15/8/29	5·7	28·77	19·81	3·30
8	Ephos phosphate, 4 cwt., 14/7/21, 11/8/24, 28/5/26, 15/8/29	5·8	31·31	22·35	3·72

The building-up process on these plots with phosphates has been remarkable. Nauru phosphate appears to lead over the period of six years, although super plus lime has done extremely well in view of the fact that the super was applied at half the rate per acre of any of the others. Ephos phosphate has also done well. The aftermath grazing

has probably been best on super plus lime, although all the manured plots have received good attention. The control plot has been comparatively neglected by stock, and is very outstanding in this respect.

Table 3.—Follett's Section.

Plot No.	Treatment per Acre.	Green Weight per Acre—One Cut, 1929.	Total Green Weight per Acre—One Cut annually for Three Years.
		Tons.	Tons.
1	Super, 3 cwt., 30/7/27, 23/7/28, 15/8/29 ..	10·7	24·75
2	Ordinary Nauru, 3 cwt. (Same dates as for Plot 1)	10·3	22·8
3	Special Nauru, 3 cwt. (Same dates as for Plot 1)	10·4	21·27
4	Seychelles phosphate, 3 cwt. (Same dates as for Plot 1)	10·8	23·69
5	Control	8·0	15·80
6	Super, 3 cwt. (Same dates as for Plot 1) ..	9·9	24·9
7	Sulphurophos, 3 cwt. (Same dates as for Plot 1)	9·5	23·12
8	Control	7·5	15·58
	Applied transversely over Plots 1 to 8.		
9	Sulphate of ammonia, 1 cwt., 20/9/27, 29/9/28, 19/9/29	11·1	20·54
10	Nitrochalk, 1 cwt., 20/9/27, 29/9/28, 19/9/29..	11·3	21·1
11	Nitrate of soda, 1 cwt., 20/9/27, 29/9/28 ..	9·4	18·49

The general increase here has been remarkable in three years, not only on the manured plots but also on the controls, which have more than doubled their yield in this short period. From this it is obvious that this section has improved physically as a result of cleaning up, and no doubt later on the controls will settle down to a steadier production, and results from the application of manures will be more reliable. Super shows a little in the lead so far, and is followed closely by Sulphurophosphate and Seychelles phosphate with Nauru close behind. There appears to be no significant difference so far between ordinary ground Nauru phosphate and the finer material (dust collected at the crushing-works).

Special Grassland Research Work.

Mr. A. W. Hudson, Crop Experimentalist, reports as follows on the grassland research work being conducted on the Area in connection with top-dressing and other problems :—

During the past two years as much work on grassland problems as facilities would allow has been carried out at Marton. Most of this work has for its object the study of grass-production at all seasons of the year, and the trials of kinds of fertilizers and times of application, with a view to determining those practices best suited to increasing production, particularly during the periods of normally low production. Full results of the trials will be published in subsequent issues of the *Journal*. It is intended here to give only an outline of the work in progress.

The trials fall under three heads as follows: (1) Observation trials; (2) trials in which the production at all seasons is measured by cutting the grass with a lawn-mower; (3) sheep-grazing trial.

OBSERVATIONAL TRIALS.

These aim at getting some approximate information fairly rapidly regarding various forms of nitrogenous fertilizers and the newer ammonium phosphates. The effect of these is being observed on limed and unlimed ground, and such points as rapidity of response, duration of response, and effect on the botanical composition of the sward are being noted. These trials are laid down on three different pasture types.

GRASS PRODUCTION MEASURED BY LAWN-MOWER.

Most of these trials are so arranged as to maintain the swards under as natural stock-grazing conditions as possible. This is arrived at by having duplicate trials alongside one another. The grazing period of one corresponds with the mowing period of the other. Mowing and grazing are alternated on each, and by manipulation of stock all mown grass is "fed back" on the ground after it is weighed. The desirability of adhering closely to normal grazing-conditions has been well demonstrated by the fact that swards which are continuously mown soon change materially in the proportions of the species which contribute to their make-up.

The following investigations are under way:—

(1) *Effect on Seasonal Production of applying Superphosphate and Slag at different Times.*—The times of application for each are winter, spring, summer, and autumn. The results so far indicate that superphosphate lends itself admirably to manipulation of time of application to obtain decidedly beneficial results during the low-production period, which, practically speaking, extends from late January to early September. Application to well-controlled pasture about December, before the cessation of fairly regular rain, is the most effective in this respect. The next-best time is the early autumn, about March or April. Applications at these periods give decidedly better results during the autumn, winter, and early spring than dressings applied in the winter or spring. Moreover, the responses are well maintained into the high-production period.

(2) *Comparison of Superphosphate, Super plus Sulphate of Ammonia, and Super plus Sulphate of Ammonia plus Potash, and the two latter with Ammonium Phosphate and Nitrophoska respectively.*

(3) *Determination of the best Method of distributing Applications of Superphosphate.*—This trial is designed to compare heavy application at long intervals with lighter applications at more frequent intervals. Each treatment receives the same amount of manure per acre over each period of two years. Three applications a year are being used in one of the treatments. Another receives one application every second year, and so on.

(4) *Determination of the Effect of applying Nitrogen at different Times of the Year.*—Treatments are arranged so that all receive the same amount of nitrogen. Intervals of two months occur between times of application, so that there are six different times of application of nitrogen throughout the year.

(5) *Comparison between Carbonate of Lime plus Sulphate of Ammonia and Straight Sulphate of Ammonia.*—On a good many soils the use of sulphate of ammonia increases soil acidity, which is corrected by liming. A good deal of difference of opinion exists regarding the effect of mixing carbonate of lime and sulphate of ammonia before application. This trial is designed to obtain some information on the effect in the field.

(6) *Comparison between the Yields of Pasture when cut at about (a) a 2 in. Stage of Growth, and (b) a 4 in. to 5 in. Stage.*—Dr. Woodman and his colleagues at the Cambridge School of Agriculture (England) have shown that pasture cut every three weeks produces a greater amount of digestible food material than when cut every two weeks, and that two-weekly cutting gives a higher yield than weekly. The trial in question at Marton was laid down to test

the matter so far as yield of green material was concerned. The results so far confirm those of Woodman in the main, although they differ in certain respects. The growth stage of utilization has an appreciable effect on the proportions of the yield contributed by different species. The practical significance of Woodman's work is that grass should not be grazed continuously or too frequently, but that its length when stocked must be governed by the class of stock used. A three-weeks' growth of grass in the summer might be ideal for cattle, but sheep would waste far more than would be gained by allowing the herbage to grow for such a long period. (See remarks on grazing trial which follows.)

SHEEP-GRAZING TRIAL.

A trial designed to test the relative merits of phosphate treatment and phosphate plus nitrogen under a system of intensive rotational grazing was commenced in the spring of 1928. The comparison between the treatments will not be discussed here. The outstanding feature of the trial has been the extraordinary carrying-capacity of grass during the early summer months, and a few remarks relative to the phosphate-treated areas will not be out of place. The phosphate trial plots consisted of four areas, each about $\frac{5}{8}$ acre, and an auxiliary area on which the stock were put when there was no grazing on the trial areas.

The system of grazing adopted in 1929 was as follows: A "permanent" flock of about twenty sheep was grazed over the plots in rotation from May onward. The carrying-capacity from May to September ranged from five to eight sheep per acre during the different months. In October it became necessary to add to the "permanent" sheep a further twenty sheep in order to cope with the growth of grass. Later in October another twenty sheep were added, making a total of about sixty sheep on $2\frac{1}{2}$ acres (four plots each $\frac{5}{8}$ acre). The sheep were carried continuously on the four trial areas from late October to the end of January. The carrying-capacity was about twenty-four sheep per acre for over three months. In November extra sheep had to be brought in as followers for a few days to clean up the growth effectively.

A small calculation will show that while the sheep were on each individual plot the stocking was at the rate of nearly 100 per acre. The control of growth was possible only by rapid and fairly frequent grazing. During the three months in question the stock were two days on and six days off each plot in turn. Had the spelling (off) period been longer it would not have been possible to get efficient utilization. As it was the grass tended to get fouled a little in wet weather.

In February the "permanent" sheep had to be removed for breeding purposes. From May to February monthly weighings were made. In May the sheep were about nine months old and averaged about 75 lb. live weight. In February their average weight had increased to about 118 lb. They put on weight consistently during the trial. No trouble from foot-rot or parasitic diseases was experienced. The sheep drafted in during October were retained on the trial. In February the carrying-capacity was about eleven sheep per acre, and about four and two in March and April respectively when very dry weather was experienced.

The great difference between high- and low-production periods emphasizes the difficulties of the application of an intensive rotational grazing scheme in sheep-farming. The difficulties are not insurmountable on the class of land in question, and the application of the system, accompanied by conservation of a good amount of silage and hay, should be comparatively simple for the average progressive farmer.

The trial is being continued this season with ewes and lambs.

GENERAL.

Several farmers' field-days were held on the Area, also a seed-merchants' field-day, and very good attendances resulted, all expressing themselves as extremely pleased and interested in the work being done. The Area was also visited by a number of officials during the period under review.

Credit is due to Mr. W. B. Wards, Overseer, for the manner in which details of the work were carried out during the year under review.

PRESERVATION OF POME FRUITS WITH EMULSIFIED OIL SPRAY.

M. DAVEY, Orchard Instructor, Mapua, Nelson.

WITH a view to ascertaining the value of late applications of emulsified oil in the prevention of scald of Washington apples during refrigerated transport overseas a spraying of oil was applied to fifty trees of this variety in the orchard of Messrs. Jones and Shaw, Tasman, shortly before shipment last export season. The oil, at strength 1–150, was applied two hours before picking, and the fruit was graded and packed three hours later.

Unfortunately, circumstances arose which prevented a report being obtained on the fruit shipped overseas, but an inspection of a portion of the fruit which had been retained in New Zealand was made last October. The results disclosed indicate that beneficial effects supplementary to the prevention of scald may be hoped for from this treatment.

An examination of the condition of two cases taken from the stack without selection gave the following results :—

Number of Apples in Case.	Percentage in Good Condition.	Grader and Case marked.	Wilted.	Rots.
		Oil-sprayed.		
189	50·7	37·5	4·2	7·4
		Unsprayed.		
135	2·2	42·9*	8·8†	45·9

* Also wilted. † Badly wilted, also discoloured.

These results seem to indicate that late oil sprays applied to apples, and possibly pears, will not only retard and suppress the development of fungal rots, but also contribute in a very marked degree to the preservation of the fruit in a fresh and good condition for placing on both local and overseas markets.

In order to prove more conclusively the results of this treatment the Horticulture Division of the Department of Agriculture is arranging for an extension of the experiment to most of the main export varieties of apples during the current season.

BLEACHING, MUDDY DISCOLORATION, AND BLACK-SPOT DEVELOPMENT IN COLOURED CHEESE.

G. F. V. MORGAN, Dairy Bacteriologist, Dairy Division, Wellington.

DURING the past year a number of samples of coloured cheese were received at the Wallaceville Laboratory showing bleaching, muddy discoloration in the neighbourhood of open cavities and cracks, and black-spot development. In some cases all three defects were found present in the same sample.

The question of black-spot was investigated first, as the defect was confined to a very limited and local area. In the cases of two samples received showing black-spot visible particles of metal were found in the centres of the discoloured areas. At this time reports came to hand from Britain concerning black-spot in cheese investigated by Professor Leitch (Kilmarnock), showing the presence of minute quantities of lead to be the cause. The same cause was found in the case of samples of New Zealand cheese examined at Reading. At this stage an examination of definite black-spot portions of one dairy company's cheese was made at Wallaceville by Fairhall's method of micro-analysis, and lead was found to be present. This was subsequently confirmed by the examination of a duplicate sample by the Department's Chief Chemist. The test was then applied to the annatto used in colouring the cheese and gave a positive result; the presence of lead was also demonstrated by the ordinary qualitative method.

A bacteriological analysis was made of the discoloured portion at the same time, and a proteus bacterium was seen to be very prominent. This organism, when tested in annatto milk agar plates in which small quantities of lead acetate had been added, gave a positive result.

At this time experiments on bleaching were also being carried out. The principle involved in the local bleaching of coloured cheese seems to be that of a local reduction of oxygen in certain portions of matured cheese; this is in all probability due to bacterial action. It is interesting to note that the bleaching occurs in most cases in the neighbourhood of cracks and open portions of the cheese. In many cases bleaching has apparently preceded cracking of the cheese, but in these cases a close examination has shown the commencement of a slit.

In order to check the possibility of oxygen-reduction being the cause of annatto bleaching, samples of annattoed milk of varying depths of colour were made up, and chemical reducing agents were added to the coloured milk and examined by the naked eye and by means of a comparator. A considerable difference was noticed by both means in samples treated as against controls.

A number of cultures were made from bleached samples of cheese received at the Laboratory, and predominant types of organisms were picked out and introduced into test tubes containing sterile annattoed milk of identical depths of colour. These were subsequently sealed and incubated. On examination after forty-eight hours considerable reduction of colour had taken place in a number of cultures, mostly

in cultures of acid-producing organisms, but a certain number showed the reduction of annatto without the production of acidity. Culture of all the organisms tested in this manner were then introduced into experimental loaf cheddars made against uninoculated controls. These cheeses will be cut and examined later.

The types of bacteria isolated and predominant in bleached portions, as against normal coloured portions of the same cheese, were as follows : *Bacillus subtilis*, short rod (aerobacter group), several types of micrococci, *B. fluorescens liquefaciens*, yeast (found predominant in bleached and in muddy portions).

Culture suspensions were prepared from solid medium cultures and added to the cheeses at the time of hooping (not to the cheese milk) so as to secure an unequal distribution in the curd. In addition to these cultures washed cultures of *Streptococcus lactis* were added to hooped cheese curd in the same way, in order to try the possibility of an unequal development of acidity being a contributing factor in local bleaching.

It has been definitely shown that moulds introduced into cheese can cause a marked bleaching. Cultures of mould spores were originally introduced on to the surface of annatto milk agar plates and incubated at low temperatures. After several weeks' growth these cultures showed no signs of bleaching.

The oxygen-reducing powers of moulds were then tested in flasks of mould medium to which methylene blue had been added, and it was noticed that no marked reduction of methylene blue took place on the surface of the medium, though the growth of mould was extremely thick ; but reduction started from cavities at the bottom of stabs made into the body of the medium and down which the mould had been able to spread. These experiments pointed to the fact that moulds possibly use atmospheric oxygen for their metabolism, but when this becomes exhausted draw their oxygen-supply from the oxygen contained in the body of the medium in which they are growing. This principle may also apply to the growths of strictly aerobic bacteria, which are present in large numbers in most samples of cheese-milk and in the neighbourhood of cavities and cracks in cheese. Under partially anaerobic conditions bleaching may spread for considerable distances in the neighbourhood of mould growth following crack and open cavities.

To milk used for experimental cheese made under bacteriological control copper lactate was added without affecting the colour at the end of four months.

For a considerable period bleached samples of cheese received for examination were kept under observation from day to day, and it was noticed that after the bleached surface has been cut for twenty-four hours it returns to normal annatto colour, but on longer keeping darkens and finally takes on the shade seen in typical muddy discoloration. Some of the samples showed practically all the intermediate stages in change of colour from bleaching to dark grey.

The general question of discoloration in cheese was at this stage referred to the Dairy Research Institute at Palmerston North, as it was deemed that the work required more protracted investigation than had been at first anticipated.

PASTURE TOP-DRESSING IN CANTERBURY.

EXPERIMENTAL WORK BY THE FIELDS DIVISION.

(Concluded.)

A. W. HUDSON, Crop Experimentalist, Plant Research Station, and
A. Y. MONTGOMERY, Assistant Crop Experimentalist.

PART IV.—EXPERIMENTAL PLOTS CUT FOR HAY.

THE experiments here recorded were the forerunner of the series of trials reported on in Parts II and III of this series. As was indicated in Part I (*Journal* for October last), the amount of work entailed in conducting the experiments seriously limited their number. The information gained did not seem to be of sufficiently wide application, and in some cases the results were so outstanding as not to require measurement to convince farmers of the economic value of the returns. It appeared, therefore, that a more active campaign, involving a large number of observational plots, would be more effective in determining the major question—"Does a particular treatment have a visible effect on production or not?" In spite of the limited number of trials, however, they have been extremely valuable in indicating to farmers in certain districts what treatments they should apply to their pastures.

Results of Canterbury experiments cut for hay and reported on previously will be found in the following numbers of the *Journal*: June, 1925, page 393; July, 1925, page 17; April, 1927, page 252. Further work has been done on some of the trials since publication of earlier results. The salient features of the latter will be noted in discussing the results presented in this report.

Evaluation of Increases.—It is impossible to arrive at a definite value of the returns due to manuring. One hay crop represents only a portion of the growth for the whole year, and it has been shown in previous articles that the effect of a dressing of superphosphate at about 2 cwt. per acre lasts for more than one year. Further, the efficiency of haymaking methods, distance from the market if hay is sold, quality of the hay, and fluctuations in market value all influence the cost and value of the material.

In the previous reports referred to the value of hay was taken as £5 per ton. It is obvious that at the present time this figure is too high a value for hay in the field. Speaking generally, the costs in harvesting after the cutting is done depend on the weight of the crop, and should be assessed on a per-ton basis. Marketing-costs, too, are based on per-ton costs, so that each extra ton of hay produced by manuring has definite charges to be placed against it. It is considered advisable, therefore, to value hay at £3 per ton on the ground for purposes of calculating the monetary returns from manuring. This value may be too low where hay is grown near a good market, but, on the other hand, it is too high as a value for increased production of grass herbage on land which is not accessible to a market. It should be borne in mind, however, that even though the cost of manuring is

not recovered in the hay crop, as shown by the figures here presented, the general result from the hay, plus the residual effect of the dressing, plus increased benefit to stock, may provide a very profitable return.

Cost of Lime and Manures.—Carbonate of lime is now procurable at 15s. per ton, and superphosphate in round figures costs £5 10s.; 30 per cent. potash salts, which were used in some of the trials, cost about £7 10s. per ton. To these should be added costs of cartage and application, but as these vary from farm to farm no attempt has been made to set an average figure for them.

(NOTE.—Since the effect of a dressing of 1 ton of lime per acre on established pastures last for five to six years at least, it is obvious that only about one-fifth of the cost of the lime should be charged against each season. This has not been done in evaluating increases, and readers should keep the point in mind.)

FIG. 16.—PLOTS OF A "HAYED" EXPERIMENT IN PROCESS OF BEING WEIGHED.

Plots were each twice the width of a mower-cut. Alternate cuts were weighed. The unweighed strip fell astride the edge of neighbouring plots; the weighed strip occupied the middle portion of the plot. Careful driving and keeping a constant width of mower-cut ensured uniformity of areas weighed. The heaps represent material which has been weighed; it was subsequently spread out again to dry.

Methods of Harvesting and Weighing Plots.—The methods adopted were described in the *Journal* for June, 1925, page 395, and have not been altered appreciably, except in regard to size of plots. (See also Fig. 16.)

Numbers of Replications and Weighings.—Usually each treatment was replicated from six to ten times in the various experiments, and, in weighing, from twenty to 120 plots, each ½ chain long by one mower cut in width, were weighed in each treatment. As a rule the number of weighings per treatment ranged from thirty to fifty. To avoid unnecessary details the exact numbers for each trial will not be stated.

Estimation of Hay from Green Weights.—The herbage was weighed immediately it was cut. In some experiments actual determinations of the proportion of green weight to hay were made (see *Journal* for June, 1925, page 397). In other cases the hay weight is merely taken as one-third of the green weight. Numerous determinations have shown this to be a fair average figure for Canterbury conditions, and any differences of a few per cent. on either side of these figures do not affect the results materially. The figure is rather high for extra heavy crops which often hold a good deal of moisture even in dry weather.

Notes on Individual Experiments.

(1) Farm of H. Peryman and Sons, Tai Tapu.

This experiment was commenced in August, 1924. Details and results for the seasons 1924 and 1925 were published in the *Journal* for July, 1925, and April, 1927, respectively.

The chief features of these results were: (*a*) Super and basic super were not significantly different in effect. (*b*) From two hay-cuts (December, 1924, and March, 1925) the average increase from a 2 cwt. application of phosphatic fertilizer was 1·3 tons of hay per acre (average of super and basic super plots). (*c*) The phosphates applied in August, 1924, caused a further increase of 0·3 ton of hay in the first cut in December, 1925. (*d*) A further application of 2 cwt. of super in July, 1925, caused an additional increase of 0·6 ton on plots treated in the previous year. On plots previously unmanured this dressing caused an increase of 0·8 ton of hay.

The results were obviously highly paying, and the second dressing in 1925, even on top of plots treated in 1924, was fully justified. During the winter and early spring the manured plots were much more closely grazed than those without manure.

No further application of manure was made in 1926, but on 10th December, 1926, the plots were again harvested. The results are shown in Table 1.

Table 1.—Effect of Phosphate (Super and Basic Super) applied 1924, and of Super applied 1925, on Yield of Hay in December, 1926.

Treatment.	Hay Weight in Tons per Acre.*	
	Yield.	Increase over No Manure.
No manure	1·1	..
Phosphate applied 1924†	1·2	0·1
Phosphate (super) applied 1925	1·4	0·3
Phosphate applied 1924† and 1925	1·4	0·3

* Hay = 35 per cent. of green weight. † Average of super and basic super, each at 2 cwt. per acre.

Comments: The increase of 0·1 ton from the 1924 applications is not significant.* The increase of 0·3 ton from the 1925 dressing is significant and is the same as that resulting in the second hay-crop after the 1924 dressings.

* A difference is said to be significant when after statistical examination it has chances of 30 to 1 or more in its favour. A difference which is not significant has chances of less than 30 to 1 in favour of its being due to treatment. It may be due to chance variation or to treatment, but cannot be viewed with confidence as due to treatment.

Conclusions.—(1) The use of super or basic super pays handsomely in this district.

(2) A dressing of 2 cwt. per acre had an appreciable effect in the hay crop in the second season after application, but practically no effect in the third season.

(3) A dressing of 2 cwt. every year should be practised.

(2) Farm of D. Hamilton (formerly J. H. Tobeck), Tai Tapu.

This experiment was commenced in July, 1925, after the field had been top-dressed with 2 cwt. of super in the previous year with excellent results. The results from the hay crop weighed in December, 1925, were published in the *Journal* for April, 1927, page 261. The treatments per acre in 1925 were: No manure; lime (carbonate), 25 cwt.; super, 2 cwt.; lime, 25 cwt., plus super, 2 cwt. No further application of manures was made in 1926, but the hay crop was weighed in that year on 16th December. The results for the two seasons are shown in Table 2.

Table 2.—Yields of Hay in December, 1925, and December, 1926, following Application of Lime and Super in July, 1925.

Treatment.	Hay Weight in Tons per Acre.*			Profit or Loss per Acre on Treatment.
	Yield, 1925.	Yield, 1926.	Increase over No Manure for both Seasons.	
No manure	2·50	1·5	..	..
Lime	2·55	1·6	0·15	6s. loss.
Super..	2·80	1·7	0·50	19s. profit.
Lime plus super ..	2·70	1·75	0·55	7s. profit.

* 1925 hay = 29 per cent. green weight; 1926 hay = 33 per cent. green weight.

Comments: The lime increase was not significant in the 1925 season, but was so in 1926. Super and lime plus super gave significant increases in both seasons.

Conclusions.—(1) The effect of lime, although showing a loss as calculated on the effect on the hay crop in two seasons, would undoubtedly be profitable in use on good pasture which was being left down, as its effect would be prolonged. It does not appear to be of great importance on this land, however, so far as effect on yield is concerned.

(2) The effect of super, though not as marked as on Peryman's farm, is still very profitable. It must be remembered that the paddock was dressed with super in the season prior to laying down of the experiment.

(3) Farm of Mrs. Thomson, Spotswood.

This experiment was laid down in the winter of 1924, and the results from the 1924 hay crop were published in the *Journal* for April, 1927, page 254.

The treatments per acre in 1924 were: No manure; lime (carbonate), 1 ton; super, 2 cwt.; lime, 1 ton, plus super, 2 cwt. In the 1924 crop the following increases of hay per acre were recorded: From lime, 0·1 ton; super, 0·5 ton; lime plus super, 0·35 ton.

In July, 1925, the above-mentioned treatments were crossed with strips of super at 2 cwt. per acre, alternating with strips of no manure. Dry weather and shortage of feed prevented closing of the paddock for hay in 1925, but a crop was harvested on 14th December, 1926. The results are shown in Table 3.

Table 3.—Effect of Dressing of Lime and Super applied in 1924, and of Super applied in 1925, on Yield of 1926 Hay Crop.

Treatment.	Hay Weight in Tons per Acre.*		
	Yield.	Increase over No Manure.	Increase from 1925 Application of Super over 1924 Treatments.
(1) No manure	1·3	..	..
(2) Lime applied 1924	1·5	0·2	..
(3) Super applied 1924	1·65	0·35	..
(4) Lime plus super applied 1924 ..	1·9	0·60	..
(1 plus super) No manure 1924 plus super 1925	1·75	0·45	0·45
(2 plus super) Lime 1924 plus super 1925	1·95	0·65	0·45
(3 plus super) Super 1924 plus super 1925	1·9	0·60	0·25
(4 plus super) Lime plus super 1924 plus super 1925	2·1	0·80	0·20

* 1924 hay = 33·5 per cent. of green weight; 1926 hay = 34·5 per cent. of green weight.

Comments: All increases shown in columns 3 and 4 are significant. Column 4 shows the effect of super applied in 1925 in increasing the yield over the various 1924 treatments to which it was applied.

Conclusions.—(1) Lime has caused a bigger increase in the third season than in the first. The increase due to lime in the 1924 hay crop was 0·1 ton. The total hay increase for 1924 plus 1926 equals 0·3 ton. This is worth 18s., and more than meets the cost of lime. The effect in 1925 and the residual effect of the lime must be sufficient to cause a handsome profit.

(2) Super applied in 1924 continued to give a substantial increase in the third season (compare with Table 1). The first season's increase of 0·5 ton of hay was profitable in itself. Super has proved highly paying.

(3) The increase due to lime plus super is more than equal to the sum of the separate increases due to lime and super in the third season. The use of the two combines the profits and advantages to stock of each individually.

(4) The second application of super in 1925 shows sufficient increases in the second season after it was applied to more than pay for itself.

(5) There can be no doubt that the use of lime and super on this farm is a highly profitable practice. When it is considered that the increases here measured as hay are the result of only about three months' growth in two out of three years, and that the treated plots produced a greater quantity of more palatable feed during the remaining period, no further comment is needed.

(4) Farm of W. Stalker, Coldstream, Rangiora.

The pasture selected for this trial was sown down in October, 1925, with 20 lb. perennial rye-grass, 3 lb. red clover, and 3 lb. white clover, per acre, with oats and Italian rye-grass as a cover-crop. The soil is a rich silt loam.

The treatments per acre were: (1) No manure; (2) lime (carbonate), 25 cwt.; (3) super, 2 cwt.; (4) lime, 25 cwt., plus super, 2 cwt. These were applied on 16th July, 1926. A further 1 cwt. per acre was applied to the plots receiving super, each winter, for the three succeeding years on the following dates: 10th August, 1927; 15th June, 1928; 7th July, 1929.

Hay crops were harvested on 13th December, 1926, 18th December, 1927, and 9th January, 1929. Owing to a very dry spring and a shortage

of feed on the farm the field could not be closed up in the spring of 1929, so that the plots were not harvested in that year.

Observations: The effect of lime was not easily visible at any time. Superphosphate had a marked effect in stimulating clover-growth, the super plots being much more closely grazed during times when the paddock was not closed for hay. Cocksfoot, too, although not sown, came in strongly on these plots. In the autumn of 1928 flowering catsear was very prominent on the no-manure plots, but could hardly be seen on the super-treated plots.

The results of three seasons are shown in Table 4.

Table 4.—Yields of Hay for Three Seasons in 1926, 1927, and 1928.

Treatment.	Hay Weight in Tons per Acre.*				Profit per Acre, as measured in Hay Increase.
	Yield, 1926.	Yield, 1927.	Yield, 1928.	Increase over No Manure: Total for Three Seasons.	
No manure	2·9	3·0	3·2	..	..
Lime	2·9	3·2	3·4	0·4	5s.
Super	3·1	3·6	3·5	1·1	44s.
Lime plus super ..	3·1	3·8	3·6	1·4	43s.

* Hay in 1926 = 23 per cent. of green weight. The crop contained much moisture at time of cutting. Hay is reckoned as one-third the green weight in subsequent seasons.

Comments: The increases due to super and lime plus super are significant in all seasons. Lime plus super is significantly better than lime or super in 1927 and 1928.

Conclusions.—(1) Lime had no effect on yield in the first hay crop, but was effective in subsequent seasons. As indicated in Part II of this series, experience has shown that the effect of lime at about 1 ton per acre should extend over five or six years at least. This, coupled with the effect of the lime during seasons when the experimental plots were being grazed, indicates that the use of lime must be profitable in this experiment.

(2) Super has been particularly effective, giving over a ton of hay per acre increase over the three seasons. On the hay crops alone it has been highly profitable.

(3) Lime plus super does not show any greater return than super alone. The residual effect of the lime is likely to change this and cause the lime plus super combination to be superior to super alone.

(5) Farm of A. Forrest, Kaiapoi.

This experiment was laid down on a pasture about twelve years old, on a rich silt loam soil. The sward contained a good amount of perennial rye-grass, white clover, and Poa pratensis as the main constituents.

The treatments per acre, applied on 19th July, 1926, were as follows: (1) No manure; (2) lime (carbonate), 25 cwt.; (3) super, 2 cwt.; (4) lime, 25 cwt., plus super. A further dressing of 2 cwt. of super was applied to those plots receiving super in the winter of 1927. Hay crops were harvested on 22nd December, 1926, and 18th January, 1928.

Observations: At no time could the effect of any of the treatments be detected in growth or intensity of grazing by stock. Table 5 gives the yields. The only significant increase was that of 0·1 ton of hay from super in the 1926 season.

Conclusions.—None of the treatments showed a profit as measured by the hay crop. The absence of effect from super is difficult to understand, as crops in general respond to dressings of super in this district.

Table 5.—Yields of Hay in Seasons 1926 and 1927.

Treatment.	Hay in Tons per Acre.	
	Yield, 1926.	Yield, 1927.
No manure	3·2	2·4
Lime	3·1	2·4
Super	3·3	2·5
Lime plus super	3·2	2·5

(6) Farm of E. Fear (now J. H. C. Thacker), Kaiapoi.

The area selected was sown down in the spring of 1924 on a wheat crop, with the following per-acre mixture: 20 lb. perennial rye-grass, 9 lb. red clover, 3 lb. white clover. The soil is a silt on drained swamp.

Treatments per acre were applied on 23rd July, 1926, as follows: (1) No manure; (2) lime (carbonate), 25 cwt.; (3) super, 2 cwt.; (4) lime, 25 cwt., plus super, 2 cwt. The super plots were re-dressed at the rate of 1 cwt. per acre for each of the three succeeding years on the following dates: 11th August, 1927; 29th June, 1928; 12th August, 1929. Hay crops were cut in December, 1926, on 26th January, 1928, 10th and 11th January, 1929, and 11th March, 1930.

Observations: The effect of super was very marked on the growth of red clover and rye-grass. In 1929–30 the field was closed very late in the season. The plots receiving super were closely grazed when the field was closed, consequently there was a better growth on the unmanured plots. This undoubtedly was responsible for the absence of effect of treatments in the 1929–30 hay crop. Results are shown in the following table:—

Table 6.—Yields of Hay in Seasons 1926, 1927–28, 1928–29, 1929–30.

Treatment.	Hay Weight in Tons per Acre.*					
	Yield, 1926.	Yield, 1927–28.	Yield, 1928–29.	Yield, 1929–30.	Increase over No Manure: Total for Four Seasons.	Profit or Loss per Acre as measured in Hay Yield.
No manure	2·7	1·8	3·0	2·3	..	..
Lime	2·8	1·9	3·0	2·3	0·2	3s. loss.
Super	3·2	2·4	3·5	2·3	1·6	59s. profit
Lime plus super	3·2	2·5	3·6	2·3	1·8	56s. profit.

* In the 1926 season the hay was 26 per cent. of the green weight on the no-manure and lime plots, and 23 per cent. on the super and lime plus super plots. In the subsequent seasons hay was calculated as one-third of the green weight.

Comments: Lime alone was not significantly better than no manure. Lime plus super was significantly better than super in 1927–28 only. Super was significantly better than no manure in all but the last season.

Conclusions.—(1) Lime is not of great importance on this land, although its use along with super is not likely to be unprofitable when considered from the point of view of its effect on grazing, in addition to the small effect on the hay crop.

(2) Super is highly important, its use having resulted in a handsome monetary gain on the hay crop alone.

(7) Farm of J. W. Black, Culverden.

The pasture on which this trial was conducted was sown in the summer of 1927 with the rape crop, 40 lb. perennial rye-grass and 3 lb. red clover per acre being used. The soil is a very light sandy silt, and fairly stony.

Treatments per acre: (1) No manure; (2) lime (carbonate), 15 cwt.; (3) super, 2 cwt.; (4) lime, 15 cwt., and super, 2 cwt.; (5) 30 per cent. potash, 2 cwt., applied in strips across all other treatments. The treatments were applied on 22nd July, 1927. The plots receiving super were redressed at 1 cwt. per acre on 6th June, 1928, and in August, 1929. Potash was redressed at 2 cwt. per acre in August, 1929. Hay crops were harvested on 29th December, 1927, 18th December, 1928, and 6th January, 1930.

Observations: The effect of lime was not striking, but could be easily discerned, especially when combined with super. Super response was very marked at all times. In the earlier seasons it caused a big increase in red clover, rye-grass, and white and suckling clover. Latterly its effect was most pronounced on the rye-grass. In November, 1930, the super and lime plus super strips were almost pure rye-grass, with some red clover still surviving. The no-manure and lime plots were almost pure sweet vernal, the lime plots having a little more clover than the unmanured plots. Lime plus super was definitely more superior to super than lime was superior to the no-manure plots. Results are shown in Table 7.

Table 7.—Yields of Hay for 1927, 1928, and 1929-30 Seasons.

Treatment.	Hay Weight in Tons per Acre.*				Profit or Loss as Measured in Hay Crops.
	Yield, 1927.	Yield, 1928.	Yield, 1929–30.	Increase over No Manure for Three Seasons.	
No manure ..	0·6	0·8	0·13	..	..
Lime	0·7	0·8	0·16	0·13	7s. loss.
Super	1·1	2·3	0·37	2·24	107s. profit.
Lime plus super	1·3	2·8	0·43	3·00	137s. profit.

* Hay taken as one-third of green weight.

Comments: The increases of lime over no manure in 1927 and 1929–30 are significant. Lime plus super was significantly superior to super alone in all three hay crops. The increases of super over no manure are significant in all three crops. Potash (not shown in the table) increased the yield of hay in the first season, when used alone and in addition to lime, by 0·13 ton. It had no effect in conjunction with super and lime plus super. In the second and third seasons it was ineffective, although a further dressing was made in the winter prior to the last hay crop being taken.

Conclusions.—Lime proved profitable when used in conjunction with super. When used alone its effect was not paying as measured in the hay crops taken. Super proved particularly paying over the three seasons.

It is interesting to note that the total yield for the three seasons from the plots receiving lime plus super (4·53 tons) is practically treble the yield from the no-manure plots (1·53 tons). These results speak for themselves, apart from any consideration of residual effects of lime and super and effects in seasons of growth not included in the hay-growing seasons. Potash is obviously not an important factor.

(8) Farm of A. F. Marr, Methven.

The pasture under experiment was sown down with turnips in November, 1926, with the following mixture: Perennial rye-grass, 17 lb.; Italian rye-grass, 3 lb.; cocksfoot, 10 lb.; cow-grass, 5 lb.; crested dogstail, 2 lb.

The soil is a fine sandy loam to silt and somewhat stony. The rainfall is rather heavier than that for average Canterbury conditions.

Treatments per acre: (1) No manure; (2) lime (carbonate), 21 cwt.; (3) super, 200 lb.; (4) lime, 21 cwt., plus super, 200 lb.; (5) 30 per cent. potash salts, 2 cwt., applied in strips across all other treatments. The manures were applied on 1st August, 1927, when the paddock was closed for hay. Hay was cut in 1927–28 only, two cuts being taken on 13th January, 1928, and 28th March, 1928, respectively.

Results are shown in Table 8.

Table 8.—Yields from two Hay Crops taken in the one Season 1927–28.

Treatment.	Hay Weight in Tons per Acre.*		
	Yield, First Cut.	Yield, Second Cut.	Increase over No Manure, Two Cuts.
No manure	3·4	1·3	..
Lime	3·5	1·4	0·2
Super	3·7	1·4	0·4
Lime plus super	4·0	1·5	0·8

* Hay is reckoned as one-third of green weight.

Comments: All increases over no manure are significant. Lime plus super is significantly better than lime alone or super alone in both cuts. Potash had no effect on yield, and consequently is not shown in the table.

Conclusions.—On the basis of evaluation adopted, super and lime plus super have both been profitable in the first season. Lime has given much better results in combination with super than when used alone. Considering the probability that the effect of lime would extend over a period of several years, its use along with super must be very profitable indeed. Experiments 1 and 3 indicate that the super would continue to be effective to some extent for another year at least.

(9) Farm of D. H. Paterson, Temuka.

The field under experiment was sown down in March, 1927, following the harvesting of a wheat crop, with the following mixture: Perennial ryegrass, 20 lb.; red clover, 6 lb.; white clover, 2 lb. No manure was sown at time of seeding. The soil is a stiff clay loam overlying shingle.

Treatments per acre: (1) No manure; (2) lime (carbonate), 25 cwt.; (3) super, 2 cwt.; (4) lime, 25 cwt., plus super, 2 cwt.; (5) 30 per cent. potash, 2 cwt., applied in strips across all other treatments.

The treatments were applied on 19th July, 1927. On 2nd July, 1928, all the treatments were repeated. It was not intended to make a further application of lime, but owing to a misunderstanding a further application of 1 ton per acre was made. On 17th June, 1929, the super and potash plots were again dressed at 2 cwt. per acre.

Hay crops were cut on 15th December, 1927, and on 6th January, 1929. On account of dry conditions and shortage of feed the field could not be closed for hay in the spring of 1929.

Observations: The effect of lime and lime plus super was very apparent in increased growth two months after application. Subsequently lime and lime plus super plots were always outstanding. The effect of super alone was hardly discernible. In March of 1928 the area was visited and the photographs reproduced in Figs. 17 and 18 were taken. The effect of lime was astonishing. Red clover on the no-manure and super strips was stunted and yellow and a few inches high. On the lime and lime plus super strips

FIG. 17.—EXPERIMENT ON FARM OF D. H. PATERSON, TEMUKA DISTRICT.

The photo shows a wonderful response to lime on an aftermath of red clover. A hay crop had been cut three months before. The left half of clover strip received carbonate of lime, 25 cwt. per acre, in the previous winter. The right half of clover strip received lime plus super. The left half of strip showing small growth received super, and the right half no manure. Photo was taken on 13th March, 1928, nine months after dressings were applied.

FIG. 18.—SHOWING SAME EXPERIMENT AS IN FIG. 17.

This photo was taken from the top of the straw-stack which can be seen in the background of fig. 17

it was about knee high and tending to lodge in places. The yield figures do not indicate the real differences, which were most marked in the early spring and autumn. In the spring of 1930 the area was again visited. The same differences due to lime and lime plus super were apparent, even though these plots were much more closely grazed by sheep. Potash had no apparent effect at any time.

The following table gives the results :—

Table 9.—Yields of Hay in 1927 and 1928–29.

Treatment.	Hay Weight in Tons per Acre.*			Profit or Loss per Acre as measured in Hay Yield.
	Yield, 1927.	Yield, 1928–29.	Increase over No Manure for Two Hay Crops.	
No manure	2·0	1·9	..	..
Lime	2·5	2·5	1·1	32s. profit.
Super	2·1	1·9	0·1	16s. loss.
Lime plus super ..	2·7	2·7	1·4	28s. profit.

* Hay calculated as one-third of green weight.

Comments : The increases due to lime are highly significant in both crops. Lime plus super is significantly better than lime alone in both crops, although it is only in the first crop that super has given a significant increase over no manure. Potash had no effect on yield.

Conclusions.—Lime is of very great importance on this land. A good profit is shown, even when the whole of the cost of 2¼ tons of lime is charged against the increases in only two hay crops. The actual profits resulting must be several times the amount shown, and it is obvious that the effect will last for several years. Super alone is of little value, but when used on limed ground there can be no doubt that the use of super will pay handsomely, although in the table lime plus super does not show such a good profit as lime alone.

(10) Farm of A. E. Gillingham, Cave.

The pasture under trial was sown down in 1926 with a mixture of rye-grass, cocksfoot, red clover, and crested dogstail on a stiff loam soil.

Treatments per acre : No manure ; super, 2 cwt. The super was applied on 18th July, 1927. A hay crop was taken on 27th December, 1927. The experiment was not proceeded with in subsequent seasons.

Yields : On a basis of hay being equal to one-third the green weight, the yields per acre were : No manure, 1·9 tons ; super, 2·3 tons : increase, 0·4 ton. The profit on the hay crop was about 13s. per acre. Considering the residual effect of the super in the subsequent grazing, there can be no doubt that super paid well.

(11) Farm of E. Goodwin, Fairlie.

The history of this pasture is not recorded, but at the time of the experiment the main constituents were red clover, cocksfoot, timothy, and some rye-grass. The soil is a heavy rich loam.

Treatments per acre : (1) No manure ; (2) lime (carbonate), 14 cwt. ; (3) super, 2 cwt. ; (4) lime, 14 cwt., plus super, 2 cwt. ; (5) 30 per cent. potash salts, 2 cwt., sown in strips across all the other treatments. The treatments were applied on 21st and 22nd July, 1927.

A hay crop was cut on 3rd and 4th January, 1928. Unfortunately it was not possible to continue with the trial on the field selected, so another

trial was laid down on the same farm in the following season (see Experiment 12). Table 11 shows the results.

Table 11.—Yields of Hay in 1927–28 Season.

Treatment.	Hay Weight in Tons per Acre.*	
	Yield.	Increase over No Manure.
No manure	3·6	..
Lime	3·6	..
Super	3·9	0·3
Lime plus super	3·7	0·1
Lime plus super plus potash	3·9	0·3

* Hay calculated as one-third of green weight.

Comments: The increase due to super, and lime plus super plus potash, are the only ones which are significant. The increase of lime plus super plus potash over lime plus super is significant.

Conclusions.—Super has given a paying increase on the hay crop. The superiority of super over lime plus super is very unusual in Canterbury. It would be unwise to draw definite conclusions regarding lime and potash on the one season's results. The response from potash is interesting, however, in view of the results of the trial conducted on another field in the next season.

(12) Farm of E. Goodwin, Fairlie.

At the time of commencing the trial the pasture consisted mainly of rye-grass, red and white and suckling clovers, and crested dogstail.

Treatments per acre: (1) No manure; (2) lime (carbonate), 1 ton; (3) super, 2 cwt.; (4) lime, 1 ton, plus super, 2 cwt.; (5) 30 per cent. potash, 2 cwt., applied in strips across all other treatments. The treatments were applied on 10th July, 1928. A hay crop was cut on 7th and 8th January, 1929. The trial could not be continued after the first season.

Observations: At time of cutting the super and lime plus super plots were marked by a big increase of red, white, and suckling clovers. The lime and no-manure plots were mainly crested dogstail. Subsequent to the hay crop being taken off the lime plus super and super plots were much more closely grazed by stock. Results are shown in Table 12.

Table 12.—Yield of Hay in Season 1928–29.

Treatment.	Hay Weight in Tons per Acre.*		Profit or Loss per Acre as measured in Hay Crops.
	Yield.	Increase over No Manure.	
No manure	1·5	..	..
Lime	1·7	0·2	3s. loss.
Super	2·5	1·0	49s. profit.
Lime plus super	2·5	1·0	34s. profit.
Potash	1·9	0·4	9s. profit.
Lime plus potash	2·1	0·6	6s. profit.
Super plus potash	2·6	1·1	40s. profit.
Lime plus super plus potash ..	2·6	1·1	25s. profit.

* Hay calculated as one-third of green weight.

Comments: All treatments are significantly better than no manure. It is of interest to note that, although lime and super have given a definite

increase, lime plus super is no better than super. Experience indicates that the combined treatments would be superior subsequently. Potash has given significant increases when added to all other treatments. The increases are greatest when used alone or on ground limed only.

Conclusions.—All treatments, except lime alone, show a profit in the first hay crop. Considering a probable effect from lime for five years at least, there can be no doubt regarding its economic value. Potash has proved profitable in the first hay crop when used alone or with lime. The smaller effect of potash when used with super and lime plus super is of interest, and from the writers' experience unusual. It is unfortunate that this trial could not be continued.

Summary of Part IV.

(1) The results of twelve haying trials, on some of which one hay crop each year has been weighed for three seasons, are presented.

(2) Lime (carbonate), superphosphate, and lime plus super were the principal treatments under trial.

(3) The difficulty of arriving at a definite basis for the evaluation of increases on the hay crop is discussed.

(4) The conversion of the weight of green material into its equivalent hay weight, where the definite relationship of the two is not determined, is made by reckoning the weight of hay as one-third that of the green material. This figure is an approximate average of a number of determinations on different experiments.

(5) In the main the results indicate paying returns from lime and superphosphate, especially when the latter is used on ground treated with the former and reasonable allowance is made for the residual effect of the lime.

(6) In all cases where lime was effective it was still influencing yield at the time of cutting the last hay crop, so that its full beneficial effect has not been determined. Observation indicates that the effect of a dressing of 1 ton will last for five or six years at least.

(7) In one case (Experiment 1) the effect of an application of 2 cwt. of super per acre had practically gone by the time of cutting the third hay crop after application. In another case (Experiment 3) a very appreciable effect was measured in the third hay season (second hay crop) after application.

(8) Potash was used in four of the experiments (three districts), but increased yield appreciably in one district only (Experiments 11 and 12).

Acknowledgments.

The assistance given by farmers in placing fields at the disposal of the Department for the trials reported on in this series of articles is cordially acknowledged. Those Farmers' Unions which provided names of members willing to co-operate in the observational trials reported on in Part II also assisted materially, and thanks are due to them.

The earlier haying trials were laid down during the time when Mr. F. E. Ward (now Director of Agriculture, Tasmania) was in charge of the Canterbury District. Since the spring of 1928 Mr. R. McGillivray, Fields Superintendent, Christchurch, has been responsible for the work in Canterbury. Mr. E. M. Bates, Instructor in Agriculture, Ashburton,

has carried out the trials in the mid-Canterbury district. Mr. R. A. Calder, Instructor in Agriculture, Timaru, and, during the last year, Mr. K. Montgomery, Fields Instructor, Timaru, have done the work in connection with the South Canterbury trials; and Mr. W. Stafford, Instructor in Agriculture, Christchurch, assisted by others of the Fields Division staff, has carried the big load of work north of the Rakaia River during the last year.

Our thanks are also due to the State Forest Service for assistance in preparation of the maps showing the location of the experiments.

It will be gratifying to all concerned to know that the lessons taught by the series of trials undertaken are undoubtedly affecting the practice of local farmers. This is indicated by an 80-per-cent. increase in the use of lime in Canterbury in 1929–30 as compared with 1928–29. In 1928–29 7,000 tons and in 1929–30 12,500 tons were used.

GREEN-LEG OF CHICKS.

ANTI-SWEATING DEVICE FOR THE BROODER.

H. A. Kitto, Overseer, Wallaceville Poultry Station.

Many losses of brooder chicks occur each season as a result of overheating. The effect is manifested in many ways and generally induces chill following on a sweated condition, which often results in bowel trouble and a general lowering of vitality, with consequent heavy mortality. The trouble is caused chiefly by allowing the chicks to huddle, this being induced either by overcrowding or poor ventilation, and also by excessive or insufficient heat. Such overheating with its bad effects may, however, also take place on poultry plants where these conditions do not exist, and where the chicks are being reared under what may be regarded as good management.

Probably the worst effect of allowing chicks to perspire is a weakening of the limbs, the visible signs being swellings in the joints, with a gangrenous condition supervening. The swelling first makes its appearance in the hock joints, and it then travels to the wings. In a few days the neck and head swell, which is an indication that death is not far off. In cases of this kind nothing can be done for chicks which are badly affected, but those affected in the earlier stages may be saved and the trouble prevented from attacking sound chicks by finding the cause, if possible, and removing it.

At the Wallaceville Poultry Station during the breeding season of 1929, when the most modern types of canopy brooders were being used, this brooder trouble, which is commonly known to poultry-keepers as "green-leg," made its appearance towards the end of September and gradually became more serious as the weather grew warmer. The trouble was more pronounced in those cases in which chicks were reared in brooders which gave off excessive heat, such as those heated by means of coke or electricity. With lamp-heated brooders, where a uniform degree of heat can be more easily maintained, little or no trouble was experienced in this respect. The floors of the brooder-house were made of concrete, on which straw chaff was used

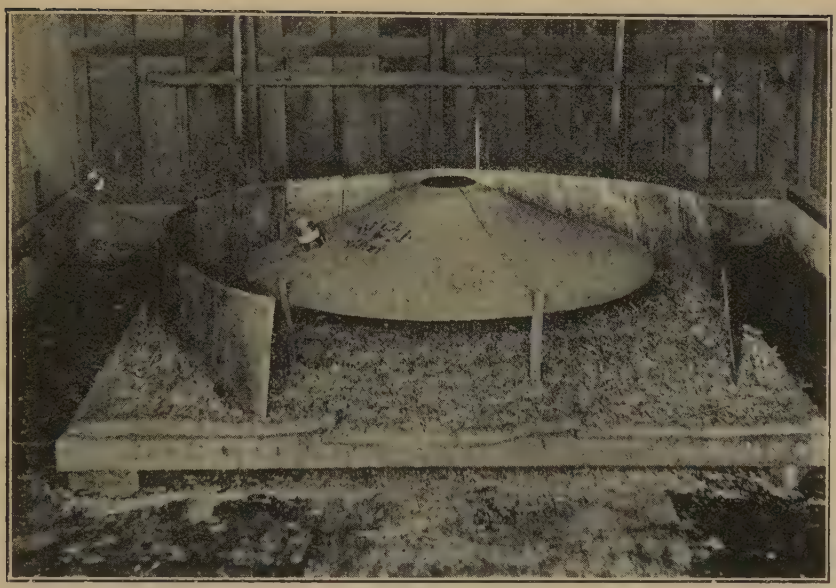


FIG. 1.—ELECTRIC BROODER AT WALLACEVILLE POULTRY STATION, STANDING ON FRAME DEVISED TO ELIMINATE SWEATING.

FIG. 2.—THE HARDENING-OFF STAGE.

The electric canopy and part of the tin fence on the frame have been dispensed with, and a perch let down to induce perching.

as bedding material, while the general conditions surrounding the young birds appeared to be all that could be desired for their welfare. Notwithstanding this the chicks under some of the brooders sweated during the night, as was indicated by the damp condition of the bedding, and the discoloration of limbs.

At the commencement of the past hatching-season the usual methods of management were varied in an endeavour to find a means of preventing the young birds from sweating, including the use of a simple arrangement in the shape of a framework base covered with wire netting. This overcame the trouble, for since its adoption sweating and its evil effects in the form of discoloration of the limbs, &c., have been entirely eliminated.

As will be seen by the accompanying photos the frame is a simple one and easy to construct. It is 6 ft. square, made of 3 in. by 2 in. timber, with 1-in.-mesh wire netting stretched tightly over the top. To support the wire netting and to prevent it from sagging, three pieces of 2 in. by 2 in. timber are placed 2 ft. apart and nailed inside the frame level with the top. The wire netting is covered with pieces of single sacking tightly stretched, and the bedding material—straw chaff, &c.—is placed on the sacking. By means of short pieces of 3 in. by 2 in. timber placed under the frame the latter is raised 3 in. above ground-level, allowing a free circulation of air underneath, thereby preventing the chicks from becoming overheated.

The frame can be easily brought into use where an electric brooder is being used. As shown in Fig. 1 the brooder can be made to stand on the top of the frame, and with other styles of brooders the principle of the frame can be easily adopted with a little ingenuity on the part of the poultry-keeper. The frame may also be made to suit the size of the brooder in use.

Green-leg is an inflammation of the veins, and is apt to affect chickens not only during the brooder stage, but also after they have been transferred to the colony house. Indeed, the trouble is more common during the later than during the earlier stage. The frame can also be used in a colony house for chickens to sleep on. As a further means of preventing trouble from sweating the chickens should be encouraged to perch at an early age, for once they have acquired this habit the trouble is seldom, if ever, experienced. Chicks should be hardened off by degrees before being transferred from the brooder, thus minimizing the risk of their huddling in corners due to the change to new quarters.

At Wallaceville Poultry Station the frame referred to has been found of value for hardening off, as even before the chickens reached the transition stage, and after the brooder had been taken away, they slept on the frame in a comfortable manner and showed no signs of making a move to huddle in the corners of the house. It will be observed from Fig. 2 that part of the removable tin fence—which latter acts as a means of preventing ground draught and also for preventing the chicks from wandering away from the brooder during their early stages—is left on the frame. The same photo also shows a folding perch let down to within a few inches above ground. This encourages the chickens to perch and thereby aids the hardening-off process.

CONFERENCE OF NEW ZEALAND WOOL INTERESTS.

POINTS EMERGING FROM THE DISCUSSION.

A CONFERENCE of Dominion wool interests, presided over by Hon. A. J. Murdoch, Minister of Agriculture, was held at Parliament Buildings, Wellington, on 8th December, 1930.

There were present Lord Barnby, Chairman of the British Wool Research Association, the Director-General of Agriculture, the Chairman of the New Zealand Research Council, the Principal of Massey Agricultural College, and representatives of the Sheepowners and Farmers' Federation, Farmers' Union, Research Department, Board of Agriculture, and Department of Agriculture.

The requirements of the wool-users and the aims of sheep-breeders were fully discussed, and the following represented the main points emerging from the discussion, these appearing to be generally acceptable to those present:—

(1) In breeding, the wool characteristics to be aimed at are as follows: (*a*) In fleeces of finer than 48's average count, the dominant aim should be to progressively mate with a view to eliminating the admixture through the fleece of coarse fibres. Once the fleece reaches a 48's count, or finer, length is of relatively little importance. (*b*) In the case of fleeces where the average fibre would be classified as of a 46's quality, or below that, length of staple and lustre should predominate.

(2) A levy on wool exported is desirable to establish a central fund to be used to the best interests of the wool-growing industry, in a manner to be decided by a representative body to be appropriately constituted. It is contemplated that economic research and publicity on extended uses of wool would be commendable purposes.

(3) Technical research on independent lines as being now carried out in New Zealand on matters connected with the field of wool-growing should cover activity in New Zealand, while technical research in wool manipulation should be done at Torridon, England; thus overlapping would be avoided.

(4) An examination should be made of the incidence of present freight rates on wool products, and the possibility of securing a reduction should be considered.

(5) Further special publicity and propaganda should be considered by the Department of Agriculture, emphasizing the following points: (*a*) The desirability of proper skirting and britching of fleeces before packing. (*b*) For marking there should only be used the fluid recommended by the British Research Association, which has been specially composed to ensure complete dissolution in scouring. (*c*) In packing wool, the outside of the pack should be turned inside, so ensuring the seam edges being outside. (*d*) That general effort be made to suppress the spiral burr (*Medicago denticulata*). (*e*) That inferior rams ought to be slaughtered.

(6) Conferences at regular periods of twelve months or less should be held between representative bodies of wool-growers concerned and representatives in New Zealand of wool manufacturing interests to discuss matters relating to wool-production and wool-quality, in order to assist towards the growing of wool of the types most suitable for manufacturers in Great Britain and other countries.

Blackleg in Calves.—The annual report for 1929–30 of the Officer in Charge of the Wallaceville Veterinary Laboratory makes the following reference to this disease: A number of recent cases of suspected blackleg have been proved to be due to the bacillus of malignant œdema. As such cases have cropped up in districts outside blackleg areas, some uneasiness has been experienced by local farmers. However, a laboratory test is always available to discriminate between the two diseases. Vaccination with a formalinized vaccine is being arranged for in place of the old powdered-muscle vaccine used for so many years in blackleg control.

SEED-TESTING NOTES.

SWEDE AND TURNIP SEED.

A fair proportion of this season's seed is of rather low germination for new-crop produce, and it would be advisable for purchasers to ascertain the germination percentage of the seed when obtaining their requirements for any autumn sowing.

IMPORTED LUCERNE.

It is generally considered that most of the imported lucerne seed on the market is of Australian origin. This is not so, as in the past year South African seed has accounted for over 90 per cent. of the total importation. This seed, of course, contains 10 per cent. stained red.

SEED STAINING.

In connection with seed-staining, generally farmers do not appreciate the fact that imported seed is stained for their protection. In several mixtures examined recently, where New Zealand or Colonial white clover had been specified, it was found that stained imported white had been supplied by the merchant. Stained white clover seed is not easily seen when in the mixture; but if a little seed is moistened and rubbed between the thumb and finger the colouring readily comes off. The staining process does not harm the seed, as an alcoholic solution is used. Clover seed steeped in alcohol for some days will germinate readily when removed and moistened with water.

SEED-TESTING FOR FARMERS.

It appears not to be generally understood that the services of the Seed-testing Station are free to all farmers requiring purity and germination tests on seed to be used for sowing purposes. Farmers would be well advised to obtain samples covering their requirements well before delivery of the seed is required, and to submit them for analysis. If the prices are given, advice as to which sample shows the best value for each kind of seed can be supplied by the Station.

—*Seed-testing Station, Department of Agriculture, Palmerston North.*

DANGER TO STOCK FROM POISONOUS PLANTS FOLLOWING SPRAYING WITH SODIUM CHLORATE.

A NOTE of warning is considered necessary in connection with the use of sodium chlorate solution when sprayed on poisonous plants. It has been observed that plants poisonous to stock, but not readily eaten normally, become attractive to them after being sprayed with sodium chlorate. In such instances mortality might result from the ingestion of the toxic plant. It is therefore a wise precautionary measure to ensure that the access of stock to recently sprayed poisonous plants, such as hemlock, foxglove, &c., should be prevented.

—*Live-stock Division.*

Correction.—In the table of pasture analyses on page 421 of last month's *Journal* the percentage of phosphoric acid for Lab. No. 4057 should read 1·05 instead of 1·51.

BURNING ACCIDENT FROM SODIUM CHLORATE.

An accident from burning after spraying weeds with sodium chlorate was recently reported in Taranaki. To get the correct particulars the writer called and saw the sufferer, Mr. G. Reed, at the Stratford Hospital, and found him badly burnt from the knee downwards, also one hand rather badly. He expected to be in hospital for three or four weeks.

The particulars are as follows: Mr. Reed had used 4 cwt. of sodium chlorate for spraying ragwort, which occupied him a considerable time. During this time he wore the same trousers, and he noticed when the work was finished that the lower part was quite stiff from saturation with the material. The work being finished he soaked the trousers in a tin of water overnight; the following morning he rubbed them down with a scrubbing-brush and hung them out to dry. A few days later he was out fencing, wearing the same trousers, and boiled a billy for lunch near a log. When taking the billy off, the trousers came into contact with the fire and burst into flames, with the aforementioned results.

Mr. Reed stated that having previously rinsed the trousers he thought they were all right and took no further precaution against fire. It would appear that the lower part of the trousers was badly saturated with the spraying solution, and that when they were soaked the whole trousers became saturated; sufficient fresh water was not used to remove the chlorate, consequently the whole trousers burnt.

From this it would appear that great care is necessary when washing clothes to use sufficient water to remove all the chlorate before exposing the material to fire. Better still to wear oilskin leggings or gum boots as advised, or old trousers and burn them when the job is finished.

—J. W. Deem, Director of the Fields Division.

SOME DAIRY INDUSTRY DATA.

For the year ended 31st March, 1930, 91,467 tons of creamery butter and 84,663 tons of cheese were graded in New Zealand for export. This produce was manufactured by 380 companies operating 477 factories.

Of these companies 129 operated 150 factories making butter. Of the 129 companies 105 with 125 factories, are co-operative, and the quantity of butter graded on their account was 82,834 tons, or 90½ per cent. of the total graded. The remaining 24 companies are proprietary concerns operating 25 factories, and the quantity of their butter graded was 8,633 tons, or equal to 9½ per cent. of the whole.

The cheese was manufactured by 253 companies, operating 327 cheese and dual-plant factories. Of these companies 242 are co-operative, operating 316 factories, and the quantity of their cheese graded was 83,851 tons, or 99 per cent. of the total graded. The remaining 812 tons, or 1 per cent. of the cheese graded, was made by 11 proprietary companies operating 11 factories.

Reducing the amount of butter and cheese made to terms of butterfat, it is found that 76,222 tons of butterfat was represented in the butter and 31,621 tons in the cheese, a total of 107,843 tons. Of this quantity 100,336 tons, or 93 per cent. was manufactured by co-operative dairy companies, and 7,507 tons, or 7 per cent., by proprietary concerns.

The total number of suppliers of milk or cream to dairy factories for the year under review was 59,417, of which 50,202 supplied co-operative companies and 9,215 proprietary companies, equal to 84½ and 15½ per cent. respectively.

Note.—Two companies operate both butter and cheese factories, and have therefore been included in each classification.

—Dairy Division.

SEASONAL NOTES.

THE FARM.

The Pastures.

It has long been recognized that the amount of production and the unit cost of production of grassland are of fundamental importance. It is now being more fully realized that these factors by themselves do not give a complete indication of the efficiency of grass-farming, and that other features of grass-production are of considerable if not of equal importance. One of these features is the seasonal distribution of production—any given tonnage of forage produced fairly evenly throughout the year as a rule is of decidedly more value than the same tonnage produced principally in relatively few months of the year. Another feature of production which is receiving more attention recently is the quality of the herbage—a supply of fresh leafy material, low in fibre or woodiness, is much more valuable in general than a similar weight of stemmy, woody material. In brief, the most efficient grass-management occurs when the four factors of production—amount, cost, season, and quality—are properly balanced.

The increased attention which more recently has been accorded season and quality of production assists in explaining some of the considerable recent changes in the year's work with the pastures. At one time grassland received little if any attention in the latter part of summer; in the light of present-day knowledge it may be said with safety that many farmers profitably could give attention to their pastures during February and March, and that the principal purpose of this attention would be better quality of herbage and more even seasonal production. Top-dressing and mowing of pastures may be advisable in February or thereabouts.

The results of field experience indicate that over a wide range of conditions some at least of the grassland on farms may fittingly be top-dressed with phosphates during the latter part of summer or autumn. When the rainfall has been adequate the application of phosphates at this season stimulates increased growth and puts the farmer in a better position to face the critical winter period. In addition the phosphates will also give increased growth during the following spring, but they will not be so productive of increased growth during the following summer as they would be were they applied in July or August. Hence a more even grass-growth over the whole year is obtained—extra growth valuable for winter requirements is secured, and to some extent the great rush of summer growth with which it is difficult to deal is avoided.

Mowing of pastures in February may be advisable in the interests both of more even seasonal production and of fresh leafy growth; if pasture-growth is rank and producing seed, mowing will tend to induce fresh leafy growth from the base of the topped plants. Mowing may also usefully be employed in the removal of the detrimental shading influence of such weeds as spear thistles, docks, fat-hen, and redshank or willow-weed. If shade-creating weeds of this nature are not removed they may readily open up the pasture in their vicinity and make way for the establishment of species inferior to those which they have replaced.

In general, because we shall have at our disposal better seed and a better knowledge of top-dressing practice, it may reasonably be expected that pastures established in the future will be more permanent than were those established in the past. From this it follows that the preparation of the ground for the sowing-down of grass is of greater importance than formerly; any weakness due to poor preparation of the ground will in

the future make its influence felt over a greater number of years. In general, the most economical means of providing the mellow, firm, seed-bed that is needed for success with pasture mixtures consists, in part at least, of commencing the preparation of the soil far enough ahead to allow natural weathering agencies to play a proper part. This matter was further referred to in these notes last month. Firmness is one of the characters which cannot readily be secured in seed-beds without adequate time for preparation, and a somewhat significant indication of the value of firmness lies in the fact that the best strikes in grassland often occur along the tracks of heavy machinery which have given additional consolidation.

As the time for the autumn sowing of pasture seed is approaching, it will be opportune for many farmers to bear in mind that important fairly recent developments have a bearing on what would be considered a suitable seed mixture for grassing down under certain conditions. One of the principal matters in this connection is that proven superior strains of important species are commercially available, and that if these species are to be used at all in permanent mixtures it is the exception for anything but the proven superior strains to be justifiable economically. The possible influence of top-dressing is another matter which at times is of basic importance in the fixing of the composition of an economical pasture mixture. These are matters which could not be dealt with satisfactorily in these notes, because it is highly desirable in drawing up seed mixtures to be guided by the circumstances of the individual case; but further information regarding specific problems is available from the officers of the Fields Division.

Where the grass-grub has been much in evidence it is not altogether desirable to sow down pastures after a cereal or a previous crop of grass, in either of which eggs may have been deposited; the less herbage land carried during November to January the more likely is it to be free of the grass-grub.

February feeding critical.

As a rule, even in the most favoured districts, the amount of butterfat produced daily falls off at an unduly rapid rate during February. The falling-off is often more than twice as great as that of January, and this rate is not normally natural. Investigation has disclosed that the cause is faulty feeding. In those instances in which good feeding is practised the rate of falling-off is similar to that which occurs in January in well-fed herds.

Sometimes, particularly in an unfavourable season, the February feeding is deficient in quantity, but more often the deficiency is in quality; an ample supply of feed of a sort is given, but it is not of the sort which allows of efficient butterfat production. Often the feed is suitable for maintaining or even for fattening stock, but it is not of the quality required for the best production from dairy cows. Feeding suitable for maintenance or fattening rather than for butterfat production results when the stock are fed on pasture that is too long and mature, or on overmature special crops such as maize or millet, or silage from grass that was cut when it was too mature. It can be taken that once flower-stalks have developed on any one of the crops mentioned, that crop is beyond the best stage for feeding for butterfat production.

In practice the principal means of avoiding the faulty February feeding should be the keeping of the pastures short and leafy. When the weather conditions do not allow of this being done satisfactorily aid may be sought in other measures, such as the feeding of silage made from immature growth, the feeding of young succulent lucerne or red clover before it has developed much woodiness and before there has been any considerable flower production, the feeding of young millet, and the feeding of soft turnips. At times heavier yields would be obtained from some of these

crops if they were not fed until of greater age. But it needs to be remembered that yield alone does not determine the cash returns from a special forage crop. For example, a 15-ton soft-turnip crop available during the critical February period may give a greater cash return than a 25-ton crop available later on when there are also ample supplies of other feed. This somewhat paradoxical result would occur because the lighter crop would serve for a short period to avoid undue falling-off, which, had it occurred, would have been reflected in the returns for several months in the remainder of the season when the critical season had passed.

During February the sheep-farmer at times finds a supply of succulent feed of great value for feeding to ewes for about a week or ten days before the rams are put out with them. Succulent feed for this purpose is furnished by rape after the first feeding-off by the lambs, or it may be obtained from the best available short pastures. At this season ewes which give indication of being too fat should be kept on short rations long enough to suitably reduce their condition.

Conservation of Moisture on Grassland.

Soil-water for the grass crop cannot be conserved by a soil mulch, but considerable moisture conservation can be secured if grazing is carried out in such a way that the bare surface of the ground is not unnecessarily exposed. The layer of herbage is similar in action to the soil mulch in checking the loss of moisture by surface evaporation. In practice this means that pastures should not be grazed too closely during the dry season —they should be left as long as is consistent with reasonable grazing control, so as to have the soil covered as much as possible with a leaf mulch. It is well to bear in mind that in endeavouring to keep the soil moist by retaining a covering of herbage in this manner there is no real occasion to neglect the proper control of the growth of pastures. In New Zealand to check the drying out of grassland many allow the grass growth to become far too long in the summer, and probably more harm is done thereby than had the error lain in the direction of keeping the herbage too short—an error which seldom occurs.

Summer Cultivation for Weed Destruction.

Summer cultivation is of outstanding value in dealing with many annual weeds such as fat-hen, willow-weed, and nightshade, which germinate in the spring. Indeed, when such weeds occur among such crops as carrots, mangels, and potatoes, summer cultivation is essential for their thorough suppression. Summer cultivation may also often be made a useful ally in the destruction of perennial weeds, but it cannot be depended upon always to give satisfactory results, particularly if it is adopted as the sole means of dealing with such weeds. Indeed, except under the conditions most favourable to it, which are not at all of wide occurrence, it is being passed over as impracticable as a sole means of destroying weeds which are somewhat difficult to deal with. Summer cultivation has been recommended against weeds of the twitchy type, such as sorrel, yarrow, couch-grass, creeping fog, and against Californian thistle. It has been proved that while summer cultivation may at times eradicate weeds of this type it calls for so much labour that it is unsatisfactory, apart altogether from the uncertainty attaching to its results.

From this it is not to be concluded that summer cultivation is useless in the destruction of twitchy weeds. The position is that to get from it its full potential value it must be linked with other suitable management measures. For instance, summer cultivation during dry conditions should be followed by the immediate sowing of a crop which grows quickly and densely. Crops with a quick dense growth have a weakening effect by

excluding direct sunlight, which is a vital necessity to practically all weeds. At times autumn-sown Algerian oats, or Italian rye-grass and red clover from which hay is eventually saved, may suitably be used to smother weeds which already have been weakened by summer cultivation. If after such dense crops the weeds still persist, they often may be dealt with effectively by growing a well-tended, well-nourished crop such as mangels, potatoes, rape, and chou moellier, or another smothering crop such as oats and peas, or oats and tares. To sum up, a suitable rotation of crops which is spread over a number of seasons, and which all the time pays its way, rather than expensive summer fallowing, is the modern economical method of bringing about the destruction of twitchy weeds.

Summer cultivation is a valuable, effective means of dealing with the seedlings of many weeds. In practice, while the first batch of seedlings of annual weeds is often effectively dealt with by suitable cultivation, subsequent batches of seedlings are allowed to develop so as to produce seed in sufficient numbers to badly foul the land, even if they do not materially reduce the yield of the crop. During January and February there is often neglect in this connection.

Seasonal Work with Special Crops.

If necessary, valuable work in respect to special crops may be done during the next few weeks. In many localities there is still time to sow turnips; suitable varieties for this purpose are Imperial and Hardy Green Globe and White Stubble. At this season swedes are less satisfactory than turnips mainly because of their uncertainty, due partly to greater possible ravages from insect pests, especially should a dry autumn be experienced. A certain amount of catch-cropping can at times advantageously be done on land which has already produced a crop in the current season. Thus, if the stubble is worked as soon as the oat crop is removed the land may be sown in Western Wolths or Italian rye-grass and red clover, which will provide autumn and winter feed that is especially likely to be valuable to sheep-farmers under Canterbury or similar conditions. Black Skinless barley sown for earliest possible use and Algerian oats for later use may also be sown for the production of green feed after oats, or after a crop of soft turnips which have been fed off early. With all these crops it is as a rule quite profitable to apply 1 cwt. to 2 cwt. of superphosphate per acre.

All crops sown in rows sufficiently wide apart call for summer intertillage at regular intervals. There can be no general rule as to the frequency of such intertillage. On soils which contain a considerable amount of fine silt or of clay, and which are therefore subject to surface-caking, a short heavy rain may so consolidate a loose surface as to make it in need of tillage even though it had been cultivated shortly prior to the rain. The aim of summer tillage should be the provision of a continuously loose surface layer of soil, this being of particular importance under dry conditions.

Summer top-dressing of lucerne with phosphates is generally profitable and preferable to the spring top-dressing which is at times practised, and which is apt to have the undesirable effect of stimulating plants, such as rye-grass and varieties of Poa, that are invading the lucerne to its detriment.

—R. P. Connell, Fields Division, Palmerston North.

Sheep-dipping.

Two dippings annually are recommended. The first should be done with a non-poisonous fluid dip from one week to two weeks after shearing, with the object of freeing the lambs from parasites which have migrated

from the ewes. The second dipping, using a powder dip, should be undertaken from two to three months after shearing. A fair growth of wool ensures more lasting benefit. Dipping should start as soon after sunrise as possible, and should not continue during the heat of the day when the weather is hot and the sun strong.

Sheep should not be dipped immediately after they have been driven any distance, nor when they have full stomachs. The sheep for the following day's dipping should be brought in and kept in a roomy yard overnight, or in a bare paddock close at hand.

The day before dipping the bath should be completely emptied and all dirt and rubbish removed, then filled with the required quantity of soft water. Procure sufficient kerosene-tins in which to mix the powder dip. After striking a packet of the dip smartly with a flat piece of wood, empty it into a tin and gradually mix water with it until it is about the consistency of porridge. Soft water is necessary, and rain-water should be used when available. If the water is hard washing-soda should be used to counteract this—from 3 lb. to 10 lb. per 100 gallons of water. The wetting-power of soft water is much greater than that of hard, and it must be remembered that the dip has the greasy fleece and skin of the sheep to contend with. Besides having marks on the bath for each 100 gallons, a measuring-stick should be made use of. The mixture in the tins is then poured into the bath when required, and the whole thoroughly stirred. Fluid dip is prepared by pouring water into the dip and mixing it before adding it to the water in the bath.

Before putting the sheep in the bath, it should be thoroughly stirred from end to end, and this stirring should be maintained throughout the whole dipping operation if the best results are to be obtained. Particles of dip are held in suspension, and if the stirring is neglected these fall to the bottom. The passage of sheep through the bath will not keep it stirred up sufficiently from the bottom as many suppose. The best thing to use for stirring is the plunger, a piece of flat board with holes in it and fastened to a pole. This is pushed to the bottom of the bath with some force and smartly drawn up again.

Care must be taken to see that the sheep are thoroughly wet to the skin. Failures sometimes occur because thorough saturation has not taken place—maybe through hard water or insufficient time in the bath. Using a guiding crutch, each sheep should be pushed completely under at least once. Lice seem to favour the breast and neck of the sheep, and may be found in the wool close up to the head. Sheep usually require to be in the bath about one minute.

The sheep must be allowed to drain thoroughly in the draining-pens, of which there should be two attached to each dip. These should be oblong rather than square, and the drainage should not re-enter the bath at the exit but near the entrance. It is desirable to keep the bath as clean as possible at the exit. Whenever any scum appears it should be skimmed off. It is an advantage to have the draining-pens covered in order to afford protection from the sun. After thorough draining the sheep should be turned into as shady a paddock as possible near the yards until they are quite dry. They should not be driven any distance until they are dry, and not overcrowded in a yard in a wet state.

It is not advisable to dip breeding-ewes within a week of the rams being turned out, nor during the tupping season. The rams should not be put through a poisonous dip when the season is close at hand. Rams require careful handling at any time in a dip.

—J. E. McIlwaine, Live-stock Division, Wellington.

THE ORCHARD.

Spraying Operations.

DURING the coming month spray controls must still continue to be the first consideration, as these operations will have an important influence on the general condition of the fruit when picked. The principal insects which will need controlling are codlin moth, leaf-roller caterpillar, red mite, apple leaf-hopper, and peach aphis. A continuation of arsenate of lead spray combined with Black Leaf 40 may be regarded as the most effective spray for control and destruction of the two first-mentioned insects. Emulsified oil at 1 – 150 to 1 – 200, combined with Black Leaf, will give a good control of the last three pests named. Judging by the experience gained last season, considerable dislodgement of the eggs of red mite deposited in the calyx and stalk cavities of the fruit may be expected from the use of emulsified red oil just prior to harvesting.

Warning: While emulsified oils have proved beneficial when fruit is reaching maturity, observation and experience this season has shown that these sprays are dangerous at the early stages of fruit-development, also that washing-soda is not the best or safest material for assisting complete emulsion of oils. Various brands of soap powders manufactured in the Dominion have proved superior, inasmuch as smaller quantities compared with soda effect the purpose and make a more thorough emulsion. Combination of lime-sulphur and arsenate of lead with emulsified oils should be regarded as highly dangerous until further experience in the use of oil in combination with these chemicals has been gained.

Fungus Diseases.

Assuming that orchardists use the aforementioned sprays for insect control, leaving black-spot to be dealt with separately, a reversion to lime-sulphur 1–100 can be resorted to for the control of the latter disease. The foliage on the trees will have become hardened by this period, and the 1–100 formula may be regarded as safe to apply to pip-fruits at this season of the year. For stone-fruits it would be better to continue with lime-sulphur at 1-125, to which precipitated sulphur may be added for the control of leaf-rust and brown-rot.

Silver-leaf.

During the growing-season those trees affected with *Stereum purpureum* will have become noticeable. Any branches of the trees which have died from the effects of this disease should be cut away well below the parts visibly affected. Removal of the bark will generally indicate the course and extent of the disease, which will have discoloured the inner bark. The necessity for prompt removal of parts which have been killed by silver-leaf is that the fungus is largely saprophytic—that is to say, it lives and develops on dead tissues from which fructification takes place. This fact also makes it essential that large dead portions of fruit-trees should not be left about in close proximity to orchards; also, dead stumps and logs of such trees as poplar and willow should be destroyed by burning. Trees which have been cut down for grafting and on which the grafts have failed, with the subsequent death of the tree, are often a source of infection to other trees. In such cases the dead stump should be removed, and burnt over the hole made in excavating the tree.

Cover-crops.

Where it is intended that cover-crops for green manure shall be ploughed under in the autumn the sowing should take place after the first substantial rain experienced in late January, otherwise the crop will be

too backward to be of much value. If the cover-crop is intended to stand over the winter, for ploughing under in the spring, sowing is best left until substantial rain has fallen towards the end of February or in early March. This practice will be found to give better results in most districts, especially where the cover-crop is to consist of blue lupin.

Budding.

The wood on both stone and pip fruits will now be ripened, and budding may be proceeded with. Budding is generally more satisfactory than grafting with stone-fruits, and it is therefore recommended where desirable to change varieties. With peaches and nectarines the operation is best delayed as long as the bark of the stock can be lifted without injury, the reason being that if the buds are inserted while sap-circulation is still vigorous gumming will often submerge the buds, or an undesirable growth will commence from the bud before the winter begins.

—M. Davey, Orchard Instructor, Mapua.

Citrus-culture.

During the months of January and February it is necessary to continue the routine work, such as spraying and cultivation.

The production of clean well-developed high-grade fruit should be the main object of every grower. Competition from other countries is keen, and fruit of high quality has to be met. It behoves every grower to do his utmost to capture and retain his own natural market, and this can only be done by placing before the public citrus-fruits that compare favourably with what has been and is still being imported.

Continue to do any pinching of strong-growing shoots that may be necessary in order to consolidate the trees and make them as compact as possible.

—L. Paynter, Orchard Instructor, Auckland.

POULTRY-KEEPING.

Management of the Growing Pullets.

THE time is now opportune to again emphasize the importance of feeding and managing the growing pullets to the best advantage. The object should be to keep them steadily growing and not force them to maturity. Some poultry-keepers imagine that by forcing pullets to an early laying-point they will be more profitable than if allowed to reach a complete stage of development before the egg-production period commences. This is a mistake. The precocious pullets will certainly give an earlier return, but in the long-run they are hardly likely to prove highly profitable stock. At the time when eggs are returning better prices they will probably go into a moult, while the naturally developed birds which commence egg-production about April, when at least six months old, will lay right through the season without moulting if properly handled.

In addition to being a more satisfactory egg-producer the well-developed bird is also vastly superior for the breeding-pen. Constitutional vigour is one of the greatest fundamental requirements in breeding heavy-producing stock, and there is no better method of promoting this than by allowing the growing bird to develop in the most natural way possible.

Where it is found that pullets are developing prematurely their diet should be changed for a plainer one. This implies spare feeding of meat, milk, &c. The danger of the high-forcing diet is especially great when substitutes such as meat-meal are employed in the mash, for the bird, if she is to get a full meal, is compelled to eat more of the concentrate than

her nature demands. Above all, one should not overlook the provision of an abundance of green material at this period of the year.

Control of Vermin.

At no other time will vermin multiply at a greater rate than during the warmer months of the year, and to keep these parasites in check continual vigilance is imperative. Apart from the direct evidence of the ill effects of vermin on feathered stock, the fact should be obvious that young stock can hardly be expected to develop satisfactorily if they are not maintained in comfort, and under conditions which make the least drain on their energy. Another point for consideration is that when these pests are numerous a bird cannot make the best use of the food it eats, and it will therefore pay well in these days of high-priced foodstuffs to continually fight vermin.

Complaints have reached me regarding the use of Black Leaf 40 when applied to the perches for ridding fowls of insect pests. One correspondent advises that the treatment had the desired effect in destroying all the vermin on his fowls, but that in some of the birds it brought about an inflamed condition surrounding the vent which resembled an ovarian disorder. He admits that the material was freely used, as the perches were given a good painting with the nicotine preparation. This correspondent now advises me to the effect that he is sure the excessive quantity of the material used was solely responsible for the harmful effect on his birds, and this seems to be borne out by the fact that when using it in lesser quantity at a later date the desired effect was achieved without the birds suffering any ill effects.

Another poultry-keeper advises that some of his birds fell from the perch soon after the Black Leaf 40 was applied to it, and remained in a dazed condition for a few minutes, after which they recovered and showed no ill effect from the treatment. This, as also the one previously mentioned, is the first case of the kind that has come under my notice, although I have seen many thousands of birds successfully treated by the Black Leaf without injury in any way. Such cases would never have occurred had the instructions been properly carried out regarding the method of using the nicotine preparation, as advised previously in the *Journal* and also in Bulletin No. 66, "Utility-poultry Keeping." In these publications it was clearly stated that a thin line of the liquid run along the perch was all that was required to free fowls from infestation by lice.

Another poultry-keeper in referring to the cost of Black Leaf 40, which he has not yet tried, asks if it would not be more economical to use other methods for controlling vermin where a large number of birds are to be treated. In my opinion the use of this preparation for ridding poultry of lice is the most effective and economical to apply, and causes less loss in egg-production than any other means yet discovered. Under the old method of dusting birds with insect-powder, it would probably take two persons at least a day to treat, say, one thousand birds, while the necessary material would probably cost double the amount required for the nicotine preparation to treat a similar number of birds, and the latter remedy could be applied by one person in less than thirty minutes. Further, with the powdering method there would necessarily be a great loss in egg-production, as each bird would require to be individually handled, whereas with the Black Leaf 40 treatment, if properly applied, the birds will not be upset in any way, nor will the egg-yield suffer. The best advice I can give in this case is to try both methods with two different flocks of birds, and observe the results from an efficiency and monetary standpoint.

—F. C. Brown, Chief Poultry Instructor, Wellington.

THE APIARY.

Extracting Operations.

EXTRACTING should now be in full swing in all districts of the Dominion. Where for any reason operations have been delayed care must be taken to see that the bees are not crowded out, or they will commence to loaf and the ultimate crop will be small. It is a good policy to extract twice during the season, but where the beekeeper prefers to leave the work until the end of the flow a close watch should be kept so as to provide ample room. This, however, can only be done where large numbers of spare combs are kept on hand. It is during the season when honey is coming in freely that the beekeeper realizes that his most valuable asset, next to his bees, is a good stock of extracting-combs. Every effort should be made to get at least twenty spare combs for each hive in the apiary, and with this number on hand the bees are not likely to be hampered for room.

In the absence of plenty of drawn-out combs the best plan is to keep the extractor going, and thus prevent the bees from blocking the brood-combs. This usually happens unless ample room is provided, and, as a result, the queens are prevented from laying to their utmost, and the colonies dwindle. At no time during the working season should the work of the queen be hindered. Care must be taken at all times to see to this important item during the flow. The honey is quite ready to extract when the combs are three parts capped, but great care must be exercised not to extract unripe honey. Numerous instances have come under my notice where the taking of unripe honey has meant a total loss to the beekeeper.

Removing Honey from the Hive.

The usual practice followed when the time for extracting is at hand is to remove the frames one by one. If excluders are used much time will be saved in picking over the combs. As the combs are taken from the hive shake off the bees in front of it, brush off any remaining bees, and place the combs in a super for removal to the honey-house. The combs should be covered with a cloth which has been previously placed in water containing a small percentage of carbolic acid. When the season is at its height very little trouble will be experienced from robbers, but in case of a stoppage in the flow this precaution is necessary. At all times the beekeeper should study his working equipment, and this is highly important when removing the honey. It will be found convenient to provide a good barrow or truck for carrying at least two full supers. Much time and labour will be saved, and the tedious work of removing the honey will be facilitated.

Straining.

Some form of strainer should be adopted to catch the larger particles of wax, dead bees, &c., in the honey as it leaves the extractor and before it finally reaches the tank. It is a simple matter to strain the honey, and yet this important part of the work receives less attention than its importance demands. It should be the aim of every beekeeper to see that his product is rendered as marketable as possible before it finally reaches the customer, and thus create a name for a high-class article. Wax is not a component part of honey, and dead bees are foreign matter, and yet they are frequently found in honey exposed for sale. Honey containing either is not likely to suit the buyer, and its selling value is consequently reduced.

To ensure that all but the smallest particles of wax will be removed, the honey should be run through a fine wire strainer, and finally passed through fine cheese-cloth before entering the tank. Cheese-cloth strainers

are cheap and easily made, and should be cleansed after each day's operations. The strainers should be of such construction as to be easily cleaned, and if the cloth is tacked into wooden frames the operation is greatly facilitated. Use cold water when cleansing the strainers; hot water melts the particles of wax, thereby clogging the holes in the cloth; whereas cold water removes all wax from the surface. Hang the strainers up to dry, so as to be ready for use when required.

Good Honey-tanks essential.

No part of the apiary equipment is of more importance at extracting-time than a good tank. From the strainers in use it is advantageous to run the honey into a tank, so that the small particles of wax that pass through the strainers will rise to the surface, when they can be skimmed off before finally drawing the honey off at the bottom of the tank. Many beekeepers run their honey direct from the strainers into tins and small packages ready for sale, with the result that the small particles of wax rise to the surface, to the detriment of the honey and its sale. Frequently complaints are made as to the quality of the honey, and not infrequently adulteration is suspected through an excess of these wax particles rising to the surface. Such honey should not find its way to market, its condition having been brought about by sheer neglect on the part of the beekeeper to provide adequate tank accommodation. By allowing the honey to settle in the tank the air bubbles escape, the small particles of wax rise to the surface, and in dry weather surplus water is evaporated.

The size of the tank to be adopted must be decided by the beekeeper himself, as it is hard to find two beekeepers with requirements alike in this matter. He must study his needs and convenience, but in any case the tank should hold enough to enable him to deal with the honey in the hives at the time of extracting.

Examination for Foul-brood.

Opportunity should be taken when removing the surplus honey to make a searching examination of the brood-chamber for disease. In this matter the beekeeper should ever be on the alert, and if disease is noticed in any of the colonies the surplus honey from such should be set aside to be extracted when all other extracting is finished. Many beekeepers spread the trouble by careless handling of diseased colonies at extracting-time. The combs from infected hives should be sterilized or destroyed after the honey has been extracted.

—E. A. Earp, Senior Apiary Instructor.

HORTICULTURE.

Berry and Bush Fruits.

WHERE strawberries are to be grown on heavy land, and especially in the wetter districts, the greatest care is needed in preparing the soil. If ploughed while it is sticky, or broken down too fine, it sets hard and is most unsuitable for the young plants. The difficulty is sometimes confined to certain low or wet patches about the area to be dealt with. These should be avoided as far as possible, choosing land that is fairly even in quality, and regarding the matter of drainage. Where ploughing is done by contract one cannot always have it done at the right moment, which is a great disadvantage; but experience has shown that this matter is one of first importance in such localities. The ploughing-in of green manures is an effective method of improving the class of land referred to.

Cane-wilt, anthracnose, and septoria spot are fungus diseases which together with boring larvæ, commonly attack bush fruits. One or two

applications of bordeaux at the present time would benefit most plantations by protecting them from the attack of fungoid parasites. In the case of raspberry and loganberry canes especially arsenate of lead should be added in places where boring insects are inclined to be troublesome. Next season's crop depends on the quality of the young canes now developing. If the growth is backward manures may be applied now to increase it, but it should be checked in sufficient time for the growth to ripen.

Marketing the Tomato Crop.

The grading and packing of imported fruit and vegetables is improving rapidly, and it is now generally of a very high order. Stacks of such produce in the sale-rooms are exceedingly attractive; the consistent quality and clean package of uniform size creates confidence and greatly facilitates sales. Many New Zealand growers have little opportunity of seeing this excellent demonstration of standard-packed, well-ripened, and graded produce. If they did so they would quickly realize that the import section of the produce trade must extend rapidly unless domestic produce is marketed in an equally convenient and reliable manner. There is a very strong sentiment in favour of New Zealand produce, but wholesale and retail buyers are not always in a position to be able to afford to pay dearly for it, especially in the face of competition.

The domestic produce trade in most of the larger and more progressive countries has had to modify its methods during recent years in the face of bulk consignments, graded and standard-packed, from overseas. It looks very much as if we should soon have to do something of the kind if we are to hold our own markets. The tomato-growers are to be complimented on the commencement they have made in this direction. It is now for individual growers to put into practice those decisions already made in conference, and to advocate a careful study of the subjects of packing and transport with a view to keeping abreast of the times. Other kinds of fresh produce are also affected, as they are likely to be neglected where more attractive substitutes are available.

Market-garden Crops.

The celery crop must never be allowed to dry. In dry localities it is grown in shallow trenches to facilitate watering, and water should be given generously as required. For commercial cropping ground that is naturally moist is necessary, and the crop may then be planted in shallow drills. The late crop should now be well established, and should receive occasional dressings of fertilizer to induce tender rapid growth. Last season some sticks were of poor texture, either fibrous or hollow. This will be avoided if the growth is steadily maintained, and if in addition to the sulphate of ammonia an equal quantity of sulphate of potash is given. Apply 1 oz. of the mixture to the square yard occasionally after rain.

The crop should be nearly full grown before blanching is commenced. If growing in trenches, see that they are thoroughly moist before this operation, but the foliage should be dry and the suckers removed. For small crops a collar of brown paper 6 in. to 8 in. high may be fastened round the base of the plant, and two others fixed above it at intervals of about a fortnight. About three weeks later the crop will be ready for harvesting. Larger crops should be earthed up, or the sticks blanched as required by placing wide boards along the rows on each side. Some early crops will soon be ready for this treatment, but the main crops generally will not be ready for blanching before March.

Useful supplies of vegetables for early spring use may be obtained by sowing now cabbage, cauliflower, shorthorn carrots, and spinach. Sow the cabbage and cauliflower thinly in seed-beds, with a view to planting out in firm, moderately rich ground in April. The carrots should remain

in the land during the winter, and when lifted early in September will be useful to follow after the main crop, which will then be used up.

The autumn-sown onion crop should be harvested as soon as the tops fall. Dry the bulbs well out, and store them in a dry airy place, large quantities stacked together will heat and deteriorate. Slatted boxes filled and stacked so that dry fresh air can pass through the stacks readily is a suitable method of storing them.

An Effective Nicotine Spray.

A concentrated nicotine extract when thoroughly diluted is a popular remedy for aphides and young scale insects attacking plants, but this remedy has little effect unless common soap is first dissolved in the water. These insects have a surface that is not easily wetted, and the spray runs off without effect unless the soap is included. The method is to dissolve 2 oz. of common soap, and stir three teaspoonfuls of extract in a small quantity of clean water. Pour these ingredients into 2 to 3 gallons of water, make it up to 4 gallons, and stir it well again. When the application is then made the insects are instantly wetted and the insecticide is very effective.

The Homestead Garden.

Where new lawns are to be laid down the clearing and levelling of the land should now be completed, so that it may be sown towards the end of February or within a month of that period. The ground should be evenly consolidated with a surface that slopes away from any buildings. After consolidation rake the surface to obtain an inch or so of fine loose soil, then broadcast the seed evenly during calm weather and rake it in. As a smooth surface is desirable, time and care is needed to obtain an equally firm and even surface.

The mixed herbaceous border demands a great deal of time and enthusiasm to keep it in good order. For this reason the area devoted to it should be kept well within one's resources. Such plants as peonies, however, may remain undisturbed for five to ten years with advantage. They may be obtained in shades of red and pink, also in white, and single and double. In a moist soil, deeply cultivated and enriched with cow-manure, they make a good display with a minimum of attention. In this way the shrubbery verge, in suitable places, may be made attractive and given a natural appearance. If this suggestion is accepted the land should be prepared now for planting later in the autumn.

The Christmas lily (*Lilium candidum*) is another handsome plant that dislikes to be disturbed, and dispenses fragrance and beauty for years with but little attention. Work the manures, well rotted, into the subsoil, and plant the bulbs now 4 in. or 5 in. deep.

Dried bulbs, narcissus, &c., may be obtained for planting during the first four months of the year, but most of them do best when planted as soon as possible. Many of them give surprisingly good results with little attention, and may even be grown in the lawn. A little planting of this kind is very effective, and takes off that precision that is sometimes excessive. Crocuses, yellow, white, and purple, also daffodils yellow or pheasant's eye, are very suitable. Of the narcissus, the simpler kinds are most effective, and too much variety should be avoided. Muscari, the grape hyacinth, is a rather insignificant little plant, but planted over considerable areas between shrubs about the verge of a plantation they form a very striking colour feature in the spring-time. It is a rich attractive shade of blue.

Herbaceous plants of the kinds mentioned provide colour and cut flowers in considerable variety for a long period, without the labour and attention required on mixed herbaceous borders, where many of the subjects to keep them in condition have to be replanted annually.

—W. C. Hyde, Horticulturist, Wellington.

WEATHER RECORDS: DECEMBER AND CALENDAR YEAR, 1930.

Dominion Meteorological Office.

GENERAL NOTES FOR DECEMBER.

ONCE again the Dominion as a whole experienced a cold month, the December mean temperature at many of the climatological stations being the lowest since observations were commenced. Except for the brief stormy period from the 15th to the 17th the month was not a particularly unsettled one, but from its commencement until the 18th cloudy skies were much in evidence. After the 19th warmer weather set in, and Christmas week was the warmest period experienced so far this summer, almost perfect summer weather continuing from then to the close of the month.

Owing to the coldness and low rainfall growth of vegetation was again backward and small fruits were slow in ripening. In the hill country of the North Island east coast district, especially, grass on which stock was grazing made little headway. On the other hand, the warm, dry spell towards the close of the month enabled farmers to harvest their hay crops under favourable conditions. Stock kept in good condition generally.

Rainfall was below the average over the whole of the Dominion, except at a few places in the extreme south of the South Island. The deficit was considerable in nearly all districts, but greatest in the Bay of Plenty, Gisborne, and Hawke's Bay districts of the North Island, and the Nelson and Westland districts of the South. At Tauranga, the total month's fall was only 15 points, against the December average of 375 points.

Weather and Pressure Systems.—During the month no depressions of marked intensity crossed the Dominion, and nowhere did the barometer fall below 29·50 in. Pressure was therefore nearly everywhere above the December average.

From the 1st to the 13th an anticyclone remained practically stationary over the Tasman Sea, while there was a persistent tendency for low pressure to the east of New Zealand. As a consequence the general trend of wind was from the south, although occasionally northerlies prevailed, more especially through Cook Strait. The weather during this period was mainly fair though cloudy, and temperatures remained unseasonably cool.

On the night of the 12th a small depression crossed the Dominion, and by the morning of the 13th a slight secondary centre had developed off the west coast of the South Island. The latter passed rapidly in the vicinity of Cook Strait, and the fresh southerly winds in its rear were accompanied by light rain in most districts. At Wellington, however, a heavy fall of 175 points occurred, which was more than half the total recorded for the whole month.

On the 15th another depression moved on to the Dominion, and after passing eastward during the night it became very intense. As a result a severe southerly storm set in, which continued until the 17th. The night of the 15th was a most unpleasant one, a violent southerly gale blowing at many places. The worst effects of the storm were felt in the east coast districts, and in Canterbury particularly. Rain fell in nearly all districts, with some scattered heavy falls, though precipitation was chiefly of a showery nature. Hail showers were also experienced at places, and some of the mountains received a heavy coating of snow. On the Tararuas the snow came lower down than at any time since August. The damage, however, was not considerable. Some losses of newly-shorn sheep occurred, and fruit crops suffered somewhat in the eastern districts.

After the disappearance eastwards of this storm area on the 18th the weather became generally more settled, and, except for a few isolated light showers on the 21st, 24th, 28th, and 29th, associated with slight low-pressure waves passing to the south of the Dominion, the weather continued fine until the end of the month.

RAINFALL FOR DECEMBER AND CALENDAR YEAR, 1930, AT REPRESENTATIVE STATIONS.

No.	Station.	December, 1930.			Average December Rainfall.	Calendar Year.	
		Total Fall.	Number of Wet Days.	Maximum Fall.		Rainfall in 1930.	Average Rainfall.
		North Island.					
		Inches.		Inches.	Inches.	Inches.	Inches.
1	Kaitaia	0·71	5	0·30	2·63	42·25	58·07
2	Russell	0·19	3	0·07	2·61	41·15	51·52
3	Whangarei ..	0·29	6	0·21	3·07	47·44	62·27
4	Auckland ..	0·81	12	0·29	2·93	46·80	44·85
5	Hamilton ..	1·42	6	0·56	3·69	38·79	50·88
6	Rotorua	0·58	4	0·30	3·89	46·43	55·72
7	Kawhia	1·79	12	0·30	3·43	47·06	54·33
8	New Plymouth ..	1·20	7	0·41	4·38	53·92	60·56
9	Riversdale, Inglewood	2·36	9	0·88	7·69	83·19	105·01
10	Whangamomona ..	1·73	5	0·62	5·96	59·88	78·86
11	Eltham	1·42	7	0·65	4·08	45·20	56·45
12	Tairua	0·64	2	0·40	4·60	49·31	66·78
13	Tauranga ..	0·15	5	0·06	3·75	50·73	53·51
14	Maraehako Station	1·30	6	0·90	2·81	57·57	53·61
15	Gisborne ..	0·47	6	0·20	2·37	30·84	45·85
16	Taupo	0·65	8	0·34	3·28	29·17	45·11
17	Napier	0·41	7	0·16	2·35	26·30	35·90
18	Hastings ..	0·27	6	0·17	2·08	25·70	33·09
19	Taihape	0·82	7	0·22	3·38	34·44	37·77
20	Masterton ..	2·14	6	0·77	2·94	35·37	38·97
21	Patea	1·39	10	0·53	3·66	37·83	45·17
22	Wanganui ..	0·89	7	0·40	2·72	29·64	36·44
23	Foxton	0·71	5	0·42	2·79	25·85	33·28
24	Wellington (Karori)	2·99	9	1·65	3·16	42·09	46·04
		South Island.					
25	Westport ..	4·28	10	1·34	8·45	68·24	96·80
26	Greymouth ..	2·87	11	0·84	8·72	73·13	101·17
27	Hokitika ..	3·05	12	1·15	10·63	80·57	116·35
28	Ross	3·82	11	1·20	12·34	98·10	137·98
29	Arthur's Pass ..	2·52	7	1·35	15·23	111·56	164·07
30	Okuru	4·94	7	..	11·43	108·18	147·79
31	Bainham ..	2·78	9	0·98	8·24	91·03	140·18
32	Nelson	0·67	9	0·28	2·56	25·08	37·94
33	Spring Creek ..	0·62	3	0·49	2·19	21·42	31·19
34	Tophouse ..	1·80	7	0·85	5·97	42·74	62·60
35	Hanmer Springs ..	3·03	10	0·89	3·63	32·70	41·83
36	Highfield, Waiau ..	1·86	9	0·50	2·72	32·41	33·93
37	Gore Bay ..	1·98	5	0·96	2·85	29·38	31·64
38	Christchurch ..	1·79	9	0·85	2·19	23·05	25·21
39	Timaru	0·96	9	0·36	2·51	22·06	22·78
40	Lambrook Station..	0·86	5	0·56	2·65	20·83	25·21
41	Benmore Station ..	0·69	5	0·32	2·30	15·61	25·15
42	Oamaru	1·51	14	0·30	2·26	18·12	22·18
43	Queenstown ..	1·21	8	0·43	2·57	22·67	30·69
44	Clyde	0·91	8	0·31	1·79	11·14	15·32
45	Dunedin	2·91	14	0·86	3·57	33·66	37·20
46	Wendon	2·07	12	0·32	2·72	25·77	30·23
47	Gore	2·13	15	0·57	3·29	32·09	34·34
48	Invercargill ..	2.63	19	0·50	4·15	41·86	45·95
49	Puysegur Point ..	8·04	22	3·07	7·01	86·12	86·11
50	Half-moon Bay ..	5·68	14	2·59	5·02	54·05	59·56

—*Edward Kidson, Director of Meteorological Services, Wellington, 7/1/31.*

STATISTICS OF PASTURE TOP-DRESSING ON FARMS, SEASON 1929-30.

Land District.	Actual Area Top-dressed.	Superphosphate.		Basic Slag.		Other Artificial Fertilizers.		Lime.	
		Area.	Quantity applied.	Area.	Quantity applied.	Area.	Quantity applied.	Area.	Quantity applied.
	Acres.	Acres.	Cwt.	Acres.	Cwt.	Acres.	Cwt.	Acres.	Cwt.
North Auckland ..	406,124	178,068	493,862	152,702	440,864	103,030	284,904	26,637	105,330
Auckland	948,043	743,646	1,890,841	140,348	324,708	187,147	432,574	134,297	411,045
Gisborne	49,491	40,137	85,473	3,455	6,982	7,419	15,681	2,050	6,550
Hawke's Bay	124,540	112,399	237,311	6,734	15,917	6,023	12,315	7,827	35,510
Taranaki	353,745	147,194	314,543	224,998	544,907	29,170	61,444	17,409	47,097
Wellington	329,053	232,112	516,024	71,128	173,122	32,352	70,838	26,073	199,753
Nelson	24,563	19,672	41,177	3,859	9,476	1,272	2,275	3,063	32,669
Marlborough	23,062	20,236	28,835	887	2,214	1,880	2,928	816	6,018
Westland	6,655	4,613	10,145	451	867	1,850	4,163	2,408	10,974
Canterbury	122,961	102,442	156,970	2,440	3,967	7,098	9,141	34,391	180,140
Otago	86,700	59,483	116,745	7,133	16,793	12,090	22,650	21,508	215,024
Southland	175,811	101,956	185,425	37,359	79,805	51,874	89,642	83,184	629,761
Totals, 1929-30 ..	2,650,748	1,761,958	4,077,351	651,494	1,619,622	441,205	1,008,555	359,663	1,879,871
Totals, 1928-29 ..	2,385,182	1,603,883	3,845,087	619,935	1,589,053	307,712	723,813	223,373	1,357,406

NOTE.—In cases where farmers top-dressed the same areas with two or more of the fertilizers quoted, either separately or as a mixture, duplication of such areas under the appropriate fertilizer headings may have resulted. Consequently the actual total area top-dressed is somewhat less than the sum of the areas appearing under the individual fertilizer headings.

—Census and Statistics Office

FARM MACHINERY AND ENGINES.

FOLLOWING is a summary of farm machinery and engines employed on rural holdings (outside borough boundaries) in New Zealand for the past five years :—

Class of Machinery, &c.	1926.	1927.	1928.	1929.	1930.
Milking-plants	16,391	17,090	18,049	18,756	20,415
Cream-separators	45,765	45,246	45,246	45,781	48,302
Shearing-machines—					
Plants	5,949	6,305	6,518	6,887	7,394
Stands	18,797	19,269	19,677	20,329	21,482
Wool-presses	8,641	8,832	9,504	9,235	9,906
Agricultural tractors	2,025	2,588	2,883	3,377	3,891
Reapers-and-binders	15,574	15,287	15,432	15,172	15,484
Threshing-machines	361	364	406	406	418
Chaffcutters	2,865	2,562	2,326	2,297	2,206
Water-wheels or motors	817	784	932	824	923
Electric motors	6,356	8,436	10,806	13,377	16,456
Steam-engines	473	435	505	397	398
Internal-combustion engines	19,584	18,885	18,321	18,489	19,169

—*Census and Statistics Office.*

STATISTICS OF IRRIGATED LANDS IN NEW ZEALAND.

OF the total area of irrigated lands for the year 1929–30, tabulated below, 64,791 acres are situated in the Otago Land District (Central region). The remainder consists of 50 acres of pasture in Hawke's Bay, and 1 acre of orchard and 4 acres of green fodder and root crops in the Auckland District.

Utilization of Irrigated Lands.	Area irrigated.	
	Year 1928–29.	Year 1929–30.
	Acres.	Acres.
Orchards	2,032	1,987
Green fodder and root crops	2,985	1,712
Pasture	53,104	58,214
Lucerne	1,061	2,436
Oats	365	201
Wheat	106	102
Barley	159	..
Market gardens	19	36
Hay	14	158
Totals	59,845	64,846

—*Census and Statistics Office.*

Phosphate Transport.—A new steamer, of 6,500 tons capacity, is being built at Belfast for the British Phosphate Commission, and is expected to be completed by the end of March next. She will be fitted with special appliances for laying or lifting the deep-sea moorings at Nauru and Ocean Islands.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

FEEDING LAMBS ON BLUE LUPINS.

"CONSTANT READER," Raetihi :—

Kindly advise me as to the proper time for feeding blue lupins to lambs—before or after the flowering stage; also whether it is advisable to provide a run-off or to feed the lupins continuously.

The Live-stock Division :—

Blue lupins are not considered a particularly suitable feed for lambs. Some care is necessary with this crop, as with rape and others. The crop, if fed to lambs should be used before the flowering stage; it is more succulent then. It is always advisable to provide a run-off on grass when feeding-off any forage crop, and this applies particularly in the case of lupins. Lambs should at first be allowed an hour's daily grazing on the lupin crop, and be removed to a grass paddock at the end of this time. It is perhaps not generally understood that lupins contain poisonous properties. The yellow lupin is considered to be the most toxic. All parts of the plant are poisonous, but the toxicity is increased at seeding-time; hence the advice to feed before flowering or seeding. If care is taken and the sheep are not put on to the crop when they are hungry, and thus eat only a small quantity to begin with, the crop may be fed off in the usual way, but a run-off on pasture is essential.

SEPARATED MILK FOR FOWLS.

D. M. W., Waitara :—

I live on a farm where I can get an abundant supply of separated milk for my fowls, but I have been afraid to use it, fearing it is of too forcing a nature for the breeding-hens. I am at present giving the birds one good feed a week of the milk. Will you please tell me if I could use it at present entirely instead of the morning meal of pollard, bran, meat-meal, &c., with wheat at night? If not advisable now, could I put hens on to it at the close of the breeding season? Also, how will it affect young chicks, either for pullets or cockerels? Is it best to give the curds to the fowls heated, or in the uncooked state?

The Chief Poultry Instructor :—

You did the correct thing by not giving your breeding birds an excessive amount of milk to drink; nevertheless a greater quantity could have been provided without bringing about undesirable results. Now that the close of the breeding season is at hand, and eggs will not be required for hatching purposes, you may give the birds as much milk as they can drink. Of course, in the event of ovarian troubles, or many double-yoked or shell-less eggs making their appearance, the milk ration should be reduced. It is a mistake, however, to compel the laying birds to drink a large quantity of milk merely for the purpose of quenching their thirst, particularly during hot weather. Water in addition to milk should always be available in a separate receptacle. If this course is adopted the risk of the above-mentioned troubles making their appearance will be greatly reduced. Skim-milk by itself is insufficient for the morning meal. In addition to it a mash of whole-grain wheat, maize, &c., should be provided. Seeing that you have an abundant supply of milk, there is no need to add meat meal to the ration. There is no need to cook the curds. After the whey has been poured off, it is a good plan to place the curd in an open-woven sack and allow it to drain well before being fed to the birds. There is nothing better for growing stock than milk or milk-curd, but with growing pullets too much is apt to promote egg-laying at too early an age. Hence, when it is found that the birds are showing evidence of prematurity the milk should be used sparingly, or, better still, be cut out of the ration.

SPARTINA TOWNSENDII FOR HARBOUR MUD-FLATS.

HERBERT NEAL, Port Albert :—

Could you let me know if the seed of *Spartina Townsendii* can be obtained from seed-merchants in New Zealand, and if there are any restrictions as to the planting of seed. I have a farm partly bounded by a salt-water river, and the bank is washing in a good deal, and also slips towards the mud-flats that are partly along the bank. I should think, by the article printed in the *Journal* for November, 1929, that this grass would do a lot of good on many of the mud-flats in the Kaipara Harbour.

The Fields Division :—

The seed of *Spartina Townsendii* is not stocked by any of the local seed-merchants. Mr. K. W. Dalrymple, Parewanui, Bulls, Wellington, has been cultivating the grass for some time, and you would be well advised to get in touch with him to see whether he can supply you with seeds or plants. One-year transplants give better results than sowing seed. Mr. Dalrymple has other strains of *Spartina* growing, but the only satisfactory kind is *Spartina Townsendii*. *S. Townsendii* is a tall-growing, rather rigid grass, with creeping rhizomes, which grows best below the tall vegetation (consisting usually of rushes and sea-tussocks on Kaipara Harbour) adjoining the mud-flats. This position is just below the high-water mark of spring tides. It will exist only on sea mud-flats, and does not do well where the flats are at all sandy. In planting seed, push it into the mud just deep enough to ensure its not being washed away—the shallower the better. Coverings of algæ can be utilized by putting the seed just under the surface mulch. The cuttings are planted by laying them in niches in the mud, made with a spade and closed up by trampling. The rhizomes should not be more than 2 in. or 3 in. from the surface. Plant just below the marginal strip of salt marsh turf in rows parallel to the shore, and not more than 3 ft. apart. *S. Townsendii* would probably grow satisfactorily on the Kaipara Harbour mud-flats.

DIPPING OF GOATS.

"GOATS," Tahekeroa :—

Is it advisable to dip goats which roam the hills eating blackberry, &c.? If so, at what strength should the dip be used?

The Live-stock Division :—

It is highly necessary to dip the goats, as these animals get lousy. Use the same strength of dip as would be used for sheep.

GROWTHS IN COWS' TEATS.—DEATH OF CALVES AFTER WEANING.

C. C. HOBBS, Otonga :—

I would like information on the following: (1) Cause and cure of growths about the size of a small pea in cows' teats, in some cases stopping the milk-flow. (2) Cause of calves falling away rapidly and dying after weaning.

The Live-stock Division :—

(1) Growths in cows' teats are generally resultant on an attack of mammitis, and treatment of same is unsatisfactory. An operation performed by a qualified veterinary surgeon may effect a cure, but it is doubtful. The Department does not advise the use of milk siphons in these cases.

(2) Mortality in calves after weaning is nearly always due to parasites. All calves should be drenched at weaning-time with a teaspoonful of kerol or lysol in a cupful of milk. This should be repeated in a week's time. The calves should be put in a good clean dry pasture.

Manuring of Early Potatoes.—The use of sulphate of ammonia with the early crop of potatoes in the Pukekohe district, as recommended by the Fields Division, is becoming a practice there.

INVENTIONS OF AGRICULTURAL INTEREST.

APPLICATIONS for patents, published with abridged specifications in the *New Zealand Patent Office Journal* from 20th November to 18th December, 1930, include the following of agricultural interest :—

No. 64210 : Manure-distributor ; E. Ryan and R. A. F. Ryan, Masterton. No. 64330 : Hay-rake ; S. C. D. Davies, Manaia. No. 65188 : Manure-distributor ; J. Taylor and Co., Ltd., Eltham. No. 65285 : Grab for hay-lifting ; C. W. Holman and W. Black, Hamilton. No. 65736 : Artificial cream ; Dickenson's Ltd., Dunedin. No. 65769 : Brushing-machine for sealing eggs ; T. F. Aston, Bath, England. No. 64056 : Raising pole for hay-stacker ; R. H. Brinkworth, Matangi. No. 65515 : Pulsator for milking-machine ; International Harvester Co., Chicago, U.S.A. No. 63980 : Animal-ear marker ; W. Fleming, Rahotu. No. 63988 ; Levelling implement ; C. Anderson, Shannon. No. 64370 : Milking-machine stripping attachment ; H. T. C. Champion, Wellington. No. 64716 : Animal-trap ; J. H. Turvey, Wellington. No. 65932 : Reconditioning musty grain ; E. von Horvath, Munich, Germany.

Copies of full specifications and drawings in respect of any of the above may be obtained from the Commissioner of Patents, Wellington, price 1s. is prepaid.

FORTHCOMING AGRICULTURAL SHOWS.

THE following show-dates have been notified by agricultural and pastoral associations :—

Helensville A. and P. Association : Helensville, 29th January, 1931.
Feilding A. and P. Association : Feilding, 3rd and 4th February.
Dannevirke A. and P. Association : Dannevirke, 10th and 11th February.
Buller A. and P. Association : Westport, 13th and 14th February.
Masterton A. and P. Association : Solway, 17th and 18th February.
Te Awamutu A. and P. Association : Te Awamutu, 18th February.
King Country Central A. and P. Association : Te Kuiti, 21st February.
Marton A. and P. Association : Marton, 25th February.
Auckland A. and P. Association : Auckland, 26th, 27th, and 28th February.
Katikati A. and P. Association : Katikati, 3rd March.
Taranaki Agricultural Association : New Plymouth, 4th and 5th March.
Waikato Central Agricultural Association : Cambridge, 4th and 5th March.
Mayfield A. and P. Association : Mayfield, 14th March.
Hawke's Bay A. and P. Society : Tomoana (Autumn Show), 18th March.
Methven A. and P. Association : Methven, 28th March.
Oxford A. and P. Association : Oxford, 2nd April.

Treatment for Rhizoctonia in Lucerne.—No definite cure is known when this root fungus disease has appeared in patches. Cultivation of the stand should be stopped to avoid its further spread. To check the disease patches may be dressed heavily with burnt lime, or treated with sulphate of iron at the rate of 2 cwt. per acre (1 lb. to 20 square yards).

Chou Moellier for Sheep.—Mr. M. Voss, Karere, near Palmerston North, favours chou moellier for sheep. Last season he grew 86 acres. On fertile land he sows 2 lb. of seed an acre through every coulter of a grain drill. Sowing was done at intervals from early December till mid-January, and 1½ cwt. of super per acre was applied at the same time. Eighty acres of chou moellier, plus 40 acres of good pasture as a run-off, provided the keep for 600 hoggets from February till September. For hoggets chou moellier is considered preferable to swedes because of teeth considerations. Further, on Mr. Voss's heavy damp land swedes are tramped in unduly in winter.—*Fields Division.*